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Edited by

CARLETON REA and J. RAMSBOTTOM

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NORWICH FORAY.

June 2nd to 5th, 1922.

The Spring Foray was held during the Whitsuntide holidays, with headquarters at Norwich. On the Friday evening about fifteen members assembled at the Norwich Museum, in the old Castle building, and were welcomed by the Curator, Mr Howard, and members of the Museum Committee. Interesting features of the building were pointed out, and the evening ended with a climb on the battlements from which a magnificent view of Norwich and the country round was obtained.

During the week-end the weather was dry and for the most part hot, as it had been for some time previously. Consequently the harvest of fungi was unusually small, even for a spring foray.

On Saturday, June 3rd, a delightful excursion on the Broads had been planned through the generosity of Mr Adcock, who placed his houseboat at the disposal of the party. Starting from Wroxham, the boat was towed by a small motor-boat as far as Woodbastwick, where a landing was made. The party was met here by Mr John Cator, and under his guidance Woodbastwick marsh was explored. Amongst the first finds was *Puccinia Pringsheimiana*, growing in abundance on wild Black Currant.

After lunch at Horning Ferry, motor-boat and dinghy were requisitioned to take members to South Walsham, where woods belonging to Sir Bartle Frere were worked. Here the only find of note however was a large partial ring of the Giant Puff Ball, *Lycoperdon giganteum*. Two huge specimens were secured for exhibition, and provided some merriment on the homeward journey.

Mr Adcock entertained the members to "high tea" at Horning Ferry Inn, after which a most enjoyable day finished with the boat trip homewards by way of Wroxham Broad.

Sunday morning was free, and many members took the opportunity of being shown over the Museum by the Curator.

In the afternoon a tram was taken out to Trowse, and a raid was made on grounds belonging to Mr and Mrs Colman, by whom the party were entertained to tea. A small gathering of *Hypomyces aureo-nitens* was secured in the woods, and in the garden of Mrs Colman's house Mr A. Adcock detected some lilies attacked by *Uromyces Lilii*.

In the evening Mr Adcock kindly allowed some of the members to inspect his tomato houses, with the result that several species

of fungi parasitic on tomatoes were added to the day's finds. At the house afterwards the President, Mr F. T. Brooks, gave a popular talk on Rusts, and Mr Pearson provided music in the shape of some charming folk-songs.

On Monday, June 5th, Sir Eustace Gurney's woods at Thorpe St Andrew were visited, and the homeward walk was by way of Racecourse Wood. This excursion yielded the largest number of species, though little of rarity. Mr Ramsbottom collected some very fine specimens of *Corticium Galzinii* and *Polyporus nummularius* and *P. radiatus* were among the more uncommon species obtained.

At the close of the Foray very cordial votes of thanks were given to the Museum Committee and Curator, to the various landowners who had given permission for visits to their estates, and especially to Mr Howard and Mr Adcock, who had taken so much trouble to ensure what all agreed was one of the most pleasant spring meetings on record.

N. = Norwich; *W.* = Woodbastwick; *S.W.* = South Walsham; *R.* = Thorpe St Andrew and Racecourse Woods; *H.* = Horning Ferry; *T.* = Trowse and Mrs Colman's garden.

BASIDIOMYCETES.

Armillaria mellea (Vahl) Fr., *S.W.*, *R.* (rhizomorphs).
Tricholoma gambosum Fr., *R.*
Laccaria laccata (Scop.) B. and Br., *R.*
Collybia dryophila (Bull.) Fr., *R.*
Pluteus cervinus (Schaeff.) Fr., *T.*
Entoloma rhodopolium Fr., *R.*
Pholiota praecox (Pers.) Fr., *W.*, aegerita (Porta) Fr., *T.*, mutabilis (Schaeff.) Fr., *R.*
Astrosporina sabuletorum (B. and Curt.) Rea, *R.*
Psaliota xanthoderma Genev., *T.*
Hypholoma fasciculare (Huds.) Fr., *W.*, *R.*, sublateritium (Schaeff.) Fr., *T.*, appendiculatum (Bull.) Fr., *W.*, *R.*
Psathyra fibrillosa (Pers.) Fr., *W.*
Psathyrella disseminata (Pers.) Fr., *R.*
Coprinus plicatilis (Curt.) Fr., *W.*, *R.*
Lenzites betulina (Linn.) Fr., *R.*
Boletus luteus (L.) Fr., *R.*, bovinus (L.) Fr., *R.*, luridus (Schaeff.) Fr., *R.*
Polyporus squamosus (Huds.) Fr., *S.W.* (on ash), *R.* (on *Acer pseudoplatanus*), nummularius (Bull.) Quél., *R.*, sulphureus (Bull.) Fr., *H.* (on willow), *T.*, rutilans (Pers.) Fr., *R.*, adustus (Willd.) Fr., *R.*, hispidus (Bull.) Fr., *R.*, radiatus (Sow.) Fr., *R.*, betulinus (Schrad.) Fr., *W.*, *R.*
Fomes annosus Fr., *T.*, *R.*
Polystictus versicolor (L.) Fr., *W.*, *R.*, abietinus (Dicks.) Fr., *T.*
Irpex obliquus (Schrad.) Fr., *W.*, *T.*, *R.*
Odontia farinacea (Pers.) Quél., *R.*
Stereum hirsutum (Willd.) Fr., *W.*, *T.*, *R.*, rugosum (Pers.) Fr., *S.W.*, *T.*, *R.*, purpureum (Pers.) Fr., *S.W.*, *R.*, spadiceum Fr., *T.*
Hymenochaete rubiginosa (Dicks.) Lév., *R.*
Corticium Galzinii Bourd., *R.*, Sambuci (Pers.) Fr., *T.*, confine Bourd. and Galz., *T.*, *R.*, confluens Fr., *R.*, porosum B. and Curt., *R.*
Peniophora cremea Bres., *R.*, velutina (DC.) Cooke, *R.*, setigera (Fr.) Bres., *R.*, *T.*, hydnoides C. and M., *R.*, incarnata (Pers.) Cooke, *R.*, and var. hydnoidea (Pers.) Bourd. and Galz., *T.*, cinerea (Fr.) Cooke, *R.*

Hypochnus fuscus (Pers.) Karst., *W.*
Solenia anomala (Pers.) Fr., *W.*, *R.*
Hirneola auricula-Judae (L.) Fr., *S.W.*
Exidia glandulosa (Bull.) Fr., *T.*
Dacryomyces deliquescens (Bull.) Duby, *T.*, *R.*
Calocera viscosa (Pers.) Fr., *R.*
Phallus impudicus (L.) Pers., *R.*
Bovista plumbea Pers., *T.*

UREDINEAE.

Uromyces Valerianae (Schum.) Fuck., *W.*, Scillarum (Grev.) Wint., *T.*, Lilii (Link) Fuck., *T.*
Puccinia Violae (Schum.) DC., *R.*, Malvacearum Mont., *W.*, pulverulenta Grev., *T.*, *R.*, Smyrnii Biv., *R.*, obtegens (Link) Tul., *R.*, Caricis (Schum.) Rebent., *W.*, *R.* (Aecidium on *Urtica*), Pringsheimiana Kleb., *W.*, graminis Pers. (on *Bromus sterilis*), *T.*, coronata Corda (Aecidium on *Rhamnus Frangula*), *W.*, Phragmitis Körn. (Aecidium on *Rumex* spp.), *W.*
Phragmidium violaceum (Schultz.) Wint., *T.*, *R.*
Triphragmium Ulmariae (Schum.) Link, *W.*

USTILAGINEAE.

Ustilago longissima (Sow.) Tul., *H.*, violacea (Pers.) Wint., *W.*
Tilletia debaryana Fisch. v. Waldh. on *Holcus mollis*, *W.*

DISCOMYCETES.

Acetabula vulgaris Fuck., *R.*
Lachnea hemisphaerica (Wigg.) Gill., *R.*
Ciliaria scutellata (L.) Quél., *W.*
Pyronema omphalodes (Bull.) Fuck., *R.*
Exoascus alnitorquus (Tul.) Sadeb., *H.*
Bulgaria inquinans (Pers.) Fr., *R.*
Corynella glabro-virens Boud., *H.*
Orbilia xanthostigma Fr., *R.*
Sclerotinia sclerotiorum (Lib.) Mass., *N.*
Helotium virgultorum (Wahl.) Karst., *W.*
Dasyscypha virginea (Batsch) Fuck., *W.*, *T.*, *R.*
Trichoscypha calycina (Schum.) Boud., *R.*
Mollisia cinerea (Batsch) Karst., *W.*, *R.*

PYRENOMYCETES.

Podosphaera Oxyacanthae (DC.) de By., *T.*
Erysiphe graminis DC. (on barley), *R.*
Nectria ditissima Tul. (on birch), *R.*
Hypomyces aureo-nitens Tul., *T.*
Epichloe typhina (Pers.) Tul., *W.*
Rosellinia aquila (Fr.) de Not., *R.*
Diatrypella quercina (Pers.) Nits., *R.*
Diatrype disciformis (Hoffm.) Fr., *T.*
Hypoxylon multiforme Fr., *T.*, *R.*, coccineum Bull., *S.W.* and conidial stage, *Isaria umbrina*, *R.*, fuscum (Pers.) Fr., *S.W.*
Xylaria Hypoxylon (L.) Grev., *H.*, polymorpha (Pers.) Grev., *R.*
Phyllachora Junci Fuck., *R.*
Dichaena quercina Fr., *W.*, *T.*, *R.*
Rhopographus Pteridis (Sow.) Wint., *R.*

PHYCOMYCETES.

Peronospora parasitica (Pers.) Tul.

SPHAEROPSIDEAE.

Phoma lineolata Desm., *R.* (on larch cones).
Septoria Rubi West., *W.*, *R.*, scabiosicola Desm., *H.*
Leptothyrium Castaneae (Spr.) Sacc., *R.*

HYPHOMYCETES.

Monilia aurea Gmel., *R.*
Ovularia obliqua (Cooke) Oud., *W.*
Botrytis cinerea Pers., *N.*, *W.*, *R.*
Penicillium glaucum Link, *N.*
Botryosporium pulchrum Corda (on tomato), *N.*
Verticillium albo-atrum R. and B. (on tomato), *N.*
Bispora monilioides Corda, *R.*
Cladosporium herbarum (Pers.) Lk., *N.*, fulvum Cooke, *N.*
Helminthosporium graminum Rab. (on barley), *R.*
Heterosporium gracile Sacc. (on iris), *T.*
Graphium rigidum (Pers.) Sacc., *R.*

MYXOMYCETES. (H. J. Howard.)

Badhamia panicea Rost.
Craterium minutum Fries. (weathered).
Diderma spumarioides Fries.
Didymium difforme Duby.
,, squamulosum Fries.
Stemonitis ? fusca Roth (immature).
Reticularia Lycoperdon Bull.
Lycogala epidendrum Fries.
Trichia persimilis Karst.
Arcyria incarnata Pers. var. fulgens Lister.

KESWICK FORAY.

September 15th to 21st, 1922.

The twenty-sixth Autumn Foray and Annual General Meeting, held at Keswick from Sept. 15th to 21st, proved to be a record gathering, over sixty members and friends being present. Owing to the large size of the party it was impossible to accommodate all in one hotel, but fortunately the use was obtained of a room over the public library for the exhibition of specimens and for meetings.

The first day, Saturday Sept. 15th, was given up to a whole-day expedition to Lake Thirlmere, the woods on Fisher Crag and Great How being explored. In spite of rain and rough going, the day yielded a great number of species, many of them particularly interesting. Mr Cheesman picked up a tuber-like growth which subsequently was found to be an unusually fine specimen of *Endogone lactiflua* Berk. Among other noteworthy records were *Synchytrium Taraxaci*, *Gymnosporangium clavariaeforme* and *G. Juniperi*, *Coleosporium Melampyri*, *Thecopsora Vacciniorum*, *Entoloma griseocyaneum*, and *Dictyolus muscigenus*. In the evening the Annual General Meeting was held.

Sunday morning was free, but in the afternoon some of the party visited the pine woods on Latrigg, adding a number of pine-wood species to the list. Both here and in other localities visited members were particularly interested in the abundance

of specimens of *Cordyceps militaris*. There appeared to have been an epidemic amongst Lepidoptera.

On Monday, Sept. 18th, the whole party drove to Lodore, and then split up into three sections. Some members worked through Barrow Wood and Great Wood, others went to Borrowdale, while the remainder returned to Keswick via Manistey Park and Brandlehow on the other side of Derwentwater. The low-lying ground round about Derwentwater proved rich in pasture-loving forms, such as species of Hygrophorus and Clavaria. Specially interesting records on this day were *Trichoglossum hirsutum, Elaphomyces granulatus, Hygrophorus obrusseus, Flammula rubicundula, F. scamba, Cortinarius armillatus, C. bolaris,* and *Clavaria fumosa.*

In the evening the President, Mr F. T. Brooks, delivered his Presidential address on "Some Present-Day Aspects of Mycology."

On Tuesday the party was conveyed by charabanc to the Bassenthwaite district. First of all the woods round Mire House and sawmill were examined, where specimens of *Apostemidium aridula* Karst. were obtained, and then a move was made to Armathwaite, at the head of the lake. The grounds here provided several interesting records, notably *Leotia chlorocephala, Cordyceps ophioglossoides,* and *Aleurodiscus amorphus,* the latter being found in quantity on dead limbs of Silver Firs.

In the evening Mr Somerville Hastings gave an interesting account of some observations made by him in the Alps on growth forms of *Anellaria separata.* Professor Buller read a paper on "Luminosity in Panus," and at the close provided a demonstration of luminosity of decaying leaves.

The last expedition, on Wednesday, was to the woods at Wythop and Whinlater. *Spathularia flavida, Cheilymenia dalmeniensis, Inocybe praetervisa, Cortinarius uraceus, C. myrtillinus, C. largus* and *Radulum mucidum* were among other species added to the lists. Particularly noteworthy was the great abundance of *Bulgaria inquinans* on felled oak logs.

In the evening Miss Wakefield gave a short account of six months spent in mycological work in the West Indies. Dr J. C. Walker, of the United States Department of Agriculture, contributed some remarks on the distribution of *Phoma Lingam* and *Urocystis Cepulae,* as affected by climatic factors. Mr Rea read an amusing paper on "Edible Fungi," and Professor Potter recorded some experiments on the influence of soil reaction on Wart Disease of Potatoes.

At the conclusion of the meeting votes of thanks were recorded to the various landowners who had allowed their estates to be visited, to the proprietors of the Royal Oak Hotel for arranging accommodation, and to the officers of the Society.

For assistance in the preparation of the subjoined list the Secretary is indebted to all the members of the party, but more especially to Mr Carleton Rea, Mr Ramsbottom, Mr Pearson, Dr Bayliss Elliott (Discomycetes) and Sir Henry Hawley (Pyrenomycetes).

Complete List of Species gathered during the Foray.

T. = Thirlmere; *L.* = Latrigg; *D.* = Lodore and Derwentwater; *B.* = Woods in Bassenthwaite district; *W.* = Woods at Wythop and Whinlater. Where no special locality is given the species was found in the Keswick district.

HYMENOMYCETES.

Amanita mappa (Batsch) Fr., *T.*, muscaria (Linn.) Fr., *D.*, spissa Fr., *L.*, *D.*, rubescens (Pers.) Fr., *T.*, *D.*, *B.*

Amanitopsis vaginata (Bull.) Roze, *T.*, *W.*, fulva (Schaeff.) W. G. Sm., *T.*, *D.*, adnata (W. G. Sm.) Sacc.

Armillaria mellea (Vahl) Fr., *D.*

Lepiota granulosa (Batsch) Fr., *T.*, *D.*, amianthina (Scop.) Fr., *T.*, *D.*, *B.*, carcharias (Pers.) Fr., *T.*

Tricholoma fulvum (DC.) Fr., *L.*, albobrunneum (Pers.) Fr., *T.*, *L.*, *D.*, rutilans (Schaeff.) Fr., *L.*, *D.*, psammopum Kalchbr., *L.*, cuneifolium Fr., *T.*, saponaceum Fr., *D.*, leucocephalum Fr., *L.*

Clitocybe clavipes (Pers.) Fr., *D.*, aurantiaca (Wulf.) Studer., *T.*, infundibuliformis (Schaeff.) Fr., geotropa (Bull.) Fr., *T.*, metachroa (Fr.) Berk., *L.*, fragrans (Sow.) Fr., *W.*

Laccaria laccata (Scop.) B. and Br., *T.*, *D.*, and var. amethystina (Vaill.) B. and Br., *T.*, *L.*

Collybia platyphylla (Pers.) Fr., *T.*, distorta Fr., *T.*, *D.*, butyracea (Bull.) Fr., *T.*, *L.*, *W.*, velutipes (Curt.) Fr., *W.*, cirrhata (Schum.) Fr., *W.*, tuberosa (Bull.) Fr., *W.*, rancida Fr., *L.*, ambusta Fr., *L.*, clusilis Fr., *Borrowdale.*

Mycena rubromarginata Fr., *D.*, inclinata Fr., *W.*, ammoniaca Fr., *D.*, filopes (Bull.) Fr., *B.*, Iris Berk., *T.*, haematopus (Pers.) Fr., *B.*, *W.*, sanguinolenta (A. and S.) Fr., *T.*, *L.*, *W.*, galopus (Pers.) Fr., *T.*, *L.*, *D.*, *W.*, and var. nigra Fl. Dan., *D.*, epipterygia (Scop.) Fr., *T.*, *D.*, pelliculosa Fr., *D.*, corticola (Schum.) Fr., *D.*

Omphalia muralis (Sow.) Fr., *T.*, umbellifera (Linn.) Fr., *T.*, and var. citrina Quél., *T.*, fibula (Bull.) Fr., *L.*

Pleurotus mitis (Pers.) Berk., *B.*, *W.*

Hygrophorus hypothejus Fr., *L.*, nemoreus (Lasch) Fr., *L.*, pratensis (Pers.) Fr., *T.*, *L.*, virgineus (Wulf.) Fr., var. roseipes Mass., *B.*, niveus (Scop.) Fr., *D.*, *W.*, ovinus (Bull.) Fr., *L.*, laetus (Pers.) Fr., *T.*, *D.*, *B.*, ceraceus (Wulf.) Fr., *T.*, coccineus (Schaeff.) Fr., *L.*, *D.*, turundus Fr., *B.*, obrusseus Fr., *D.*, conicus (Scop.) Fr., *T.*, *B.*, calyptraeformis Berk., *B.*, chlorophanus Fr., *D.*, *B.*, psittacinus (Schaeff.) Fr., *T.*, *L.*, *W.*, unguinosus Fr., *T.*, *W.*

Lactarius turpis (Weinm.) Fr., *B.*, blennius Fr., *L.*, *B.*, uvidus Fr., *T.*, flavidus Boud., *Portinscale*, piperatus (Scop.) Fr., *T.*, *L.*, deliciosus (Linn.) Fr., *D.*, sanguifluus (Paul.) Fr., *D.*, pallidus (Pers.) Fr., *B.*, quietus Fr., *T.*, *D.*, aurantiacus (Fl. Dan.) Fr., *B.*, vietus Fr., *T.*, rufus (Scop.) Fr., *T.*, glyciosmus Fr., *T.*, *D.*, spinosulus Quél., *Portinscale*, volemus Fr., *D.*, mitissimus Fr., *T.*, *D.*, subdulcis (Pers.) Fr., *T.*, *B.*

Russula nigricans (Bull.) Fr., *D.*, virescens (Schaeff.) Fr., *B.*, azurea Bres., *W.*, lepida Fr., *T.*, *D.*, cyanoxantha (Schaeff.) Fr., *T.*, *D.*, foetens (Pers.) Fr., *T.*, *D.*, *B.*, consobrina Fr., *B.*, and var. sororia (Larb.) Fr., *B.*, pectinata (Bull.) Fr., *W.*, ochroleuca (Pers.) Fr., *D.*, *B.*, fellea Fr., *L.*, *B.*, drimeia Cooke var. Queletii (Fr.) Bataille, *L.*, fragilis (Pers.) Fr., *D.*, and var. fallax (Schaeff.) Mass., *W.*, atropurpurea (Krombh.) Maire, *B.*, roseipes (Secr.) Bres., *B.*, nitida (Pers.) Fr., *B.*, *W.*, vesca Fr., *B.*, mustelina Fr., *B.*, lutea (Huds.) Fr., L.

Cantharellus cibarius Fr., *T.*, tubaeformis Fr. var. lutescens (Bull.) Fr., *L.*

Dictyolus muscigenus (Bull.) Quél., *T.*
Nyctalis parasitica (Bull.) Fr., *W.*
Marasmius peronatus (Bolt.) Fr., *L.*, oreades (Bolt.) Fr., *D.*, hariolorum (DC.) Quél., *T.*, *L.*, dryophilus (Bull.) Karst., *T.*, ramealis (Bull.) Fr., *W.*
Androsaceus androsaceus (Linn.) Pat., *T.*, *B.*
Panus stypticus (Bull.) Fr., *T.*, *D.*
Lentinus cochleatus (Pers.) Fr., *D.*
Pluteus nanus (Pers.) Fr., *D.*
Entoloma griseocyaneum Fr., *T.*, rhodopolium Fr., *T.*, *L.*, nidorosum Fr., *W.*, sericeum (Bull.) Fr., *D.*
Leptonia lampropus Fr., *B.*, chalybaea (Pers.) Fr., *D.*
Nolanea pascua (Pers.) Fr., *T.*, *D.*, *B.*, proletaria Fr., *T.*, *D.*, *B.*
Pholiota aurea (Mattusch) Fr., *D.*, erebia Fr., *L.*, flammans Fr., *T.*, *L.*, mutabilis (Schaeff.) Fr., *T.*, *B.*, *W.*, marginata (Batsch) Fr., *T.*, *L.*
Inocybe rimosa (Bull.) Fr., *L.*, *D.*, *B.*, geophylla (Sow.) Fr., *L.*, *B.*, cervicolor (Pers.) Quél., *T.*, *L.*, Godeyi Gill., *T.*, *B.*, cincinnata Fr., *D.*, calamistrata Fr., *D.*
Astrosporina proximella (Karst.) Rea, *D.*, praetervisa (Quél.) Schroet., *W.*, asterospora (Quél.) Rea, *L.*
Hebeloma glutinosum (Lindgr.) Fr., *T.*, mesophaeum Fr., *T.*, *B.*
Flammula rubicundula Rea, *D.*, inopus Fr., *L.*, *D.*, sapinea Fr., *T.*, scamba Fr., *D.*
Galera hypnorum (Schrank) Fr., *T.*, *D.*, *B.*, mycenopsis Fr., *L.*
Tubaria furfuracea (Pers.) W. G. Sm., *T.*, *L.*
Crepidotus applanatus (Pers.) Fr., *D.*
Cortinarius (Phlegmacium) triumphans Fr., *T.*, largus Fr., *W.*, decolorans (Pers.) Fr., *W.*
—— (Myxacium) elatior Fr., *T.*, *D.*, *B.*
—— (Inoloma) alboviolaceus (Pers.) Fr., *D.*, bolaris (Pers.) Fr., *D.*, pholideus Fr., *T.*, *D.*
—— (Dermocybe) tabularis (Bull.) Fr., *T.*, caninus Fr., *D.*, albocyaneus Fr., *B.*, anomalus Fr., *T.*, lepidopus Cooke, *D.*, myrtillinus Fr., *W.*, semisanguineus (Brig.) Maire, *L.*, cinnabarinus Fr., *B.*, sanguineus (Wulf.) Fr., *L.*, *D.*, cinnamomeus (Linn.) Fr., *T.*, *L.*, *D.*, cotoneus Fr., *D.*
—— (Telamonia) torvus Fr., *T.*, armillatus Fr., *D.*, hemitrichus Fr., *D.*, *W.*, rigidus (Scop.) Fr., *D.*, *W.*, paleaceus (Weinm.) Fr., *D.*, *W.*
—— (Hydrocybe) subferrugineus (Batsch) Fr., *T.*, saturninus Fr., *T.*, uraceus Fr., *W.*, jubarinus Fr., *T.*, dolabratus Fr., *D.*, leucopus (Bull.) Fr., *L.*, scandens Fr., *B.*, obtusus Fr., *T.*
Paxillus involutus (Batsch) Fr., *T.*, *D.*
Psaliota villatica (Brond.) Magn., *L.*, haemorrhoidaria Kalchbr., *B.*
Stropharia aeruginosa (Curt.) Fr., *T.*, *L.*, *D.*, merdaria Fr., *D.*, *B.*, semiglobata (Batsch) Fr., *T.*
Hypholoma sublateritium (Schaeff.) Fr., *T.*, *D.*, fasciculare (Huds.) Fr., *T.*, *L.*, *D.*, dispersum Fr., *B.*, lacrymabundum Fr., *W.*, pilulaeforme (Bull.) Fr., *D.*, hydrophilum (Bull.) Fr., *W.*
Psilocybe sarcocephala Fr., *T.*, ericaea (Pers.) Fr., *T.*, semilanceata Fr., *T.*, *L.*, *D.*, *B.*
Psathyra conopilea Fr., *W.*
Coprinus atramentarius (Bull.) Fr., *D.*, *B.*, picaceus (Bull.) Fr., *W.*, micaceus (Bull.) Fr., *L.*, *D.*, plicatilis (Curt.) Fr., *D.*
Panaeolus campanulatus (Linn.) Fr., *D.*, *W.*
Anellaria separata (Linn.) Karst., *L.*, *B.*
Psathyrella gracilis Fr., *W.*
Gomphidius gracilis B. and Br., *T.*, *L.*
Boletus elegans (Schum.) Fr., *T.*, *L.*, *D.*, viscidus (Linn.) Fr., *L.*, badius Fr., *T.*, *B.*, piperatus (Bull.) Fr., *T.*, chrysenteron (Bull.) Fr., *T.*, edulis (Bull.) Fr., *T.*, calopus Fr., *T.*, *Borrowdale*, porphyrosporus Fr., *D.*, versipellis Fr., *T.*, scaber (Bull.) Fr., *T.*, *D.*, rugosus Fr., *D.*
Polyporus perennis (Linn.) Fr., *T.*, *D.*, varius Fr., *W.*, squamosus (Huds.) Fr., *D.*, betulinus (Bull.) Fr. *T.*, *D.*, amorphus Fr., *B.*

Fomes igniarius (Linn.) Fr., ferruginosus (Schrad.) Mass., *W.*, annosus Fr., *T.*, *W.*
Ganoderma applanatum (Pers.) Pat., *D.*
Polystictus versicolor (Linn.) Fr., *T.*
Poria sanguinolenta (A. and S.) Fr., *L.*, hymenocystis B. and Br., *T.*, *L.*, *D.*, *W.*
Daedalea quercina (Linn.) Fr., *D.*
Hydnum repandum (Linn.) Fr., *T*
Irpex obliquus (Schrad.) Fr., *T.*
Radulum mucidum (Pers.) Bourd. and Galz., *W.*
Phlebia merismoides Fr., *T.*, *D.*, *W.*
Odontia farinacea (Pers.) Quél., *T.*, *W.*
Grandinia granulosa Fr., *W.*
Thelephora palmata (Scop.) Fr., *D.*, anthocephala (Bull.) Fr., *L.*, terrestris (Ehrh.) Fr., *L.*
Stereum hirsutum (Willd.) Fr., *T.*, *W.*, *D.*, purpureum (Pers.) Fr., *D.*, spadiceum Fr., *T.*, *W.*, rugosum (Pers.) Fr., *T.*, sanguinolentum (A. and S.) Fr., *T.*, *D.*, *B.*
Hymenochaete rubiginosa (Dicks.) Lév., *D.*, corrugata (Fr.) Lév., *T.*, *W.*
Aleurodiscus amorphus (Pers.) Rabenh., *B.* (on *Abies*).
Corticium laeve (Pers.) Fr., *T.*, atrovirens Fr., *B.*, Sambuci (Pers.) Fr., *W.*, trigonospermum Bres., *W.*, subcoronatum v. H. and L., *B.*, confluens Fr., *W.*, confine Bourd. and Galz., *B.*, echinosporum Ell., *D.*, porosum B. and C., *B.*
Peniophora glebulosa (Fr.) Bres., *T.*, sanguinea (Fr.) Bres., *T.*, gigantea (Fr.) Mass., *B.*, cinerea (Fr.) Cooke, *W.*
Coniophora puteana (Schum.) Karst., *W.*, arida Fr., *W.*
Hypochnus fuscus (Pers.) Fr., *T.*, *B.*, *W.*, fumosus Fr., *L.*, *D.*, botryoides (Schw.) Burt, *T.*
Clavaria cristata (Holmsk.) Fr., *T.*, cinerea (Bull.) Fr., *T.*, *W.*, rugosa (Bull.) Fr., *L.*, *B.*, Kunzei Fr., *T.*, corniculata (Schaeff.) Fr., *L.*, *W.*, luteoalba Rea, *L.*, inaequalis (Müll.) Fr., *T.*, *L.*, *W.*, vermicularis Fr., *L.*, fumosa (Pers.) Fr., *D.*
Pistillaria quisquiliaris Fr., *D.*, puberula Berk., *D.*
Hirneola auricula-Judae (Linn.) Berk., *W.*
Ecchyna faginea (B. and Br.) Fr., *W.*
Tremella frondosa Fr., *W.*, foliacea (Pers.) Fr., *T.*, *L.*, *D.*, mesenterica (Retz.) Fr., *T.*, *W.*
Exidia glandulosa (Bull.) Fr., *T.*, nucleata (Schw.) Rea, *L.*, *B.*, Thuretiana (Lév.) Fr., *B.*
Dacryomyces deliquescens (Bull.) Duby, *T.*, *L.*
Calocera viscosa (Pers.) Fr., *T.*, *L.*, cornea (Batsch) Fr., *T.*

GASTEROMYCETES.

Phallus impudicus (Linn.) Pers., *T.*
Mutinus caninus (Huds.) Fr., *L.*
Lycoperdon caelatum (Bull.) Fr., *B.*, depressum Bon., *D.*, umbrinum Pers., *L.*, *D.*, pyriforme (Schaeff.) Pers., *T.*
Geaster fimbriatus Fr., *T.*
Nidularia confluens Fr , *Portinscale.*
Crucibulum vulgare Tul., *D.*
Scleroderma vulgare (Hornem.) Fr., *L.*, verrucosum (Vaill.) Pers., *D.*
Sphaerobolus stellatus (Tode) Pers., *W.*

UREDINEAE.

Uromyces Trifolii-repentis (Cast.) Lindr., *T.*, Alchemillae (Pers.) Lév., *T.*
Puccinia Violae (Schum.) DC., *T.*, Hieracii (Schum.) Mart., *T.*, Menthae Pers., *B.*, annularis (Str.) Schlecht., *T.*, obscura Schroet., *W.*, holcina Eriks., *T.*, Poarum Niels., *T.*
Gymnosporangium clavariaeforme (Jacq.) Rees, *T.*, *L.*, Juniperi Lk., *T.*
Phragmidium Sanguisorbae (DC.) Schroet., *Portinscale,* subcorticium (Schrank) Wint., *L.*

Xenodochus carbonarius Schlecht., *D.*
Coleosporium Melampyri (Rebent.) Kleb., *T.*, *D.*, Tussilaginis (Pers.) Kleb., *T.*
Pucciniastrum Circaeae (Schum.) Schroet., *T.*, *B.*
Melampsoridium betulinum (Pers.) Kleb., *T.*
Thecopsora Vacciniorum (Link) Karst., *T.*
Milesina Blechni (Syd.) Magn., *D.*, *B.*, Dieteliana Syd., *B.*

PYRENOMYCETES.

Sphaerotheca Castagnei Lév., *D.* (on Burnet).
Podosphaera Oxyacanthae (DC.) de By, *L.*
Microsphaera Grossulariae (Wallr.) Lév.
Phyllactinia suffulta (Rebent.) Sacc., *T.*
Erysiphe Polygoni DC., on *Circaea*, Martii Lév., *T.*
Apiosporium pinophilum (Nees) Fuck., *D.*
Nectria cinnabarina (Tode) Fr., *T.*, *L.*, *W.*, sanguinea Fr., *W.*
Hypomyces rosellus Tul., luteovirens (Fr.) Plowr., *Portinscale.*
Hypocrea rufa (Pers.) Fr.
Cordyceps militaris (L.) Link, *T.*, *L.*, *B.*, ophioglossoides (Ehrb.) Link, *B.*
Claviceps microcephala (Wallr.) Wint., on *Nardus*, *Borrowdale.*
Sordaria fimicola (Rob.) Ces. and de Not. (on rabbit dung).
Sporormia intermedia Auersw. (on rabbit dung).
Bertia moriformis (Tode) de Not.
Rosellinia velutina Fuck.
Melanomma pulvis-pyrius (Pers.) Fuck.
Stigmatea Robertiani Fr., *T.*
Tichothecium erraticum Massal., gemmiferum (Tayl.) Koerb.
Ophiobolus porphyrogonus (Tode) Sacc.
Diaporthe pulla Nke, strumella (Fr.) Fuck., sorbicola (Nke) Schroet, controversa (Desm.) Fuck., revellens Nke, leiphaemia (Fr.) Sacc.
Valsa ambiens Fr., decorticans Fr. (on beech).
Eutypa lata Tul.
Eutypella stellulata (Fr.) Sacc.
Diatrype stigma (Hoffm.) de Not., *W.*, favacea Fr., bullata (Hoffm.) Fr.
Diatrypella quercina (Pers.) Nke, verrucaeformis (Ehrh.) Nke.
Hypoxylon multiforme Fr., *T.*, coccineum Bull., *T.*, fuscum Fr., *W.*, semi-immersum Nke.
Xylaria Hypoxylon (L.) Grev., *L.*
Phyllachora graminis (Pers.) Fuck., *T.*
Plowrightia ribesia Sacc.

HYSTERIACEAE.

Rhopographus Pteridis (Sow.) Wint., *W.*
Hysterium pulicare (Pers.) Fr., *D.*
Lophodermium Pinastri (Schrad.) Chev., *B.*, *D.*
Dichaena faginea Fr., var corylea Fr.

TUBERACEAE.

Elaphomyces granulatus Fr., *B.*, *D.*

DISCOMYCETES.

Rhizina inflata (Schaeff.) Karst., *L.*
Galactinia badia (Pers.) Boud., *T.*
Peziza aurantia Pers., *T.*, *W.*
Ciliaria scutellata (Linn.) Quél., *D.*, trechispora (B. and Br.) Boud., *Borrowdale.*
Cheilymenia dalmeniensis (Cooke) Boud., *W.*, coprinaria (Cooke) Boud., *B.*, *D.*
Coprobia granulata (Bull.) Boud., *T.*
Ascobolus viridulus Phill. and Plowr., *T.*, atrofuscus Phill. and Plowr., *D.*
Taphrina aurea (Pers.) Fr., *T.*
Trichoglossum hirsutum (Pers.) Boud., *D.*
Microglossum viride (Pers.) Gill., *Borrowdale.*
Spathularia clavata (Schaeff.) Sacc., *W.*

Leotia lubrica (Scop.) Pers., *T.*, *D.*, atrovirens Pers., *W.*
Cudoniella acicularis (Bull.) Schroet., *T.*, *D.*
Apostemidium aridula Karst., *B.*
Ombrophila faginea (Pers.) Boud., *B.*
Calycella claroflava (Grev.) Boud., *L.*, *T.*, *D.*, sublenticularis (Fr.) Boud., *W.*
Coryne sarcoides (Jacq.) Tul., *T.*, *L.*
Bulgaria inquinans (Pers.) Fr., *T.*, *D.*, *W.*
Polydesmia pruinosa (B. and Br.) Boud., *L.*, *D.*
Orbilia xanthostigma Fr., *L.*, *W.*, curvatispora Boud., *L.*, *D.*
Sclerotinia Curreyana (Berk.) Karst., *D.*, *W.*
Phialea firma (Pers.) Gill., *T.*, *W.*
Helotium scutula (Pers.) Karst., *D.*
Dasyscypha virginea (Batsch) Fuck., *T.*, *D.*, *W.*
Trichoscypha calycina (Schum.) Boud., *T.*, *L.*, *D.*
Arachnopeziza aurata Fuck., *D.*
Hyaloscypha hyalina (Pers.) Boud., *T.*, *D.*, *B.*
Mollisia cinerea (Batsch) Karst., *T.*
Tapesia caesia (Pers.) Fckl., *D.*
Pezicula rhabarbarina (Berk.) Tul., *D.* (on *Rubus*).
Phacidium multivalve (DC.) Kunze and Schm., *L.*, *D.*
Stegia Ilicis Fr., *T.*
Rhytisma acerinum (Pers.) Fr., *T.*

PHYCOMYCETES.

Endogone lactiflua Berk., *T.*
Synchytrium Taraxaci de By. and Wor., *T.*
Syzygites megalocarpus Ehrb., *D.*

SPHAEROPSIDEAE.

Phoma lineolata Desm., *L.*
Marssonia Potentillae (Desm.) Fisch., var. Tormentillae Trail, *B.*
Leptothyrium quercinum (Lasch) Sacc., *D.*

HYPHOMYCETES.

Oidium alphitoides Griff. and Maubl., *D.*
Trichoderma viride (Pers.) Fr., *T.*, *W.*
Botrytis Tilletii Desm., *D.*
Ramularia Primulae Thuem., *W.*, Taraxaci Karst., *T.*, Armoraciae Fuck.
Ovularia obliqua (Cooke) Oud., *L.*, *D.*
Fumago vagans (Pers.) Fr.
Bispora monilioides Corda, *L.*
Cercospora Mercurialis Passer., *W.*
Isaria arachnophila Ditm., *D.*
Ptychogaster albus Corda, *T.*, *L.*, *D.*

KESWICK LICHENS.

By H. H. Knight, M.A.

In a mountainous country like the Lake District one expects to see plenty of Lichens, and we were not disappointed. In the woods visited during the foray corticolous Lichens were not plentiful except in some of the old woods in the Borrowdale Valley. Here were seen some of the more showy Lichens belonging to the family *Stictaceae*, also *Parmeliella plumbea*.

There are two types of rock around Keswick, the volcanic rocks to the south of the town, and the slates of Skiddaw and the hills round Bassenthwaite. The hard volcanic rocks are the most suitable for Lichens, the slate rocks not producing so many species. As there is no limestone, many common Lichens are absent from the list. Miss Noel sent three Lichens from Shap in the neighbouring county of Westmorland where the carboniferous limestone occurs. These are included in the list. The Lichen parasites *Ticothecium gemmiferum* Koerb. and *T. erraticum* Massal. were found, the former being common. I am much indebted to Mr R. Paulson for help in making out this list.

Calicium hyperellum Ach.
Sphaerophorus globosus Wain.
S. fragilis Ach.
Ephebe lanata Wain.
Leptogium lacerum S. F. Gray.
Parmeliella plumbea Wain.
Pannaria rubiginosa Del.
var. conoplea Koerb.
Peltigera canina Willd.
P. rufescens Hoffm.
var. praetexta Nyl.
P. polydactyla Hoffm.
P. horizontalis Hoffm.
Sticta fuliginosa Ach.
Lobaria scrobiculata DC.
L. laetevirens A. Zahlbr.
L. pulmonaria Hoffm.
Parmelia physodes Ach.
P. perlata Ach.
P. caperata Ach.
P. scortea Ach.
P. saxatilis Ach.
P. sulcata Ach.
P. dubia Tayl.
P. revoluta Floerke.
P. conspersa Ach.
P. omphalodes Ach.
P. fuliginosa Nyl.
var. laetevirens Nyl.
Cetraria glauca Ach.
C. aculeata Fr.
f. hispida Cromb.
Evernia prunastri Ach.
E. furfuracea Mann, Shap.
Ramalina calicaris Ach.
R. farinacea Ach.
Usnea florida Web.
var. hirta Ach.
Alectoria jubata Ach.
Xanthoria parietina Th. Fr.
X. lychnea Th. Fr.
Placodium ferrugineum Hepp.
var. festivum A. L. Sm.
Candelariella vitellina Müll.-Arg.
Physica pulverulenta Nyl.
P. grisea A. Zahlbr.
Physica hispida Tuckerm.
Rinodina demissa Arn.
R. subarenaria A. L. Sm.
Lecanora subfusca Ach.
var. chlarona Ach.
L. atra Ach.
L. pallida Schaer.
L. subcarnea Ach.
L. varia Ach.
L. symmictera Nyl.
var. aitema Nyl.
L. sulphurea Ach.
L. polytropa Schaer.
L. argopholis Ach.
L. badia Ach.
L. atriseda Nyl.
L. tartarea Ach.
L. subtartarea Nyl.
L. parella Ach.
L. cinerea Sommerf.
L. gibbosa Nyl.
L. subdepressa Nyl.
L. superiuscula Nyl., a form with larger spores than hitherto described.
L. lacustris Th. Fr.
L. Dicksonii Nyl.
L. epulotica Nyl., Shap.
Acarospora fuscata Th. Fr.
Haematomma ventosum Massal.
Pertusaria faginea Leight.
P. lactea Nyl.
P. pertusa Dal. Tor. and Sarnth.
P. dealbata Cromb.
P. leioplaca Schaer.
P. Wulfenii DC.
Diploschistes scruposus Norm.
Baeomyces rufus DC.
B. roseus Pers.
Stereocaulon evolutum Graewe.
S. denudatum Floerke.
var. pulvinatum Th. Fr.
Cladonia rangiferina Web.
C. sylvatica Hoffm.
C. uncialis Web.
C. foliacea Willd.

Cladonia pyxidata Hoffm.
C. fimbriata Fr.
C. cervicornis Schaer.
C. gracilis Willd.
C. furcata Schrad.
C. squamosa Hoffm.
C. subsquamosa Nyl.
C. caespiticia Floerke.
C. digitata Hoffm.
C. deformis Hoffm.
C. coccifera Willd.
C. flabelliformis Wain.
C. Floerkeana Fr.
var. carcata Wain.
Coenogonium ebeneum A. L. Sm.
Lecidea ostreata Schaer.
L. confertula Stirt.
L. lucida Ach.
L. coarctata Nyl.
L. granulosa Schaer.
L. flexuosa Nyl.
L. demissa Th. Fr.
L. uliginosa Ach.
L. parasema Ach.
L. sublatypea Leight.
L. paneola Ach.
L. contigua Fr.
f. calcarea Leight.
L. sorediza Nyl.
L. albocoerulescens Ach.
L. crustulata Koerb.
var. meiospora Oliv.
L. confluens Ach.
f. oxydata Leight.
L. plana Nyl.
L. lactea Floerke.
Lecidea fuscoatra Ach.
L. Kochiana Hepp.
var. lygaea Leight.
L. griseoatra Schaer.
L. asperella Stirt.
L. sanguinaria Ach.
Biatorina lenticularis Koerb.
Bilimbia cuprea Massal.
B. sabuletorum Br. and Rostr.
var. simplicior A. L. Sm.
B. lignaria Massal.
Bacidia umbrina Br. and Rostr.
Buellia myriocarpa Mudd.
B. impressula A. L. Sm.
B. disciformis Mudd.
B. colludens Tuckerm.
Rhizocarpum Oederi Koerb.
R. geographicum DC.
R. viridiatrum Koerb.
R. confervoides DC.
R. obscuratum Massal.
Arthonia radiata Ach.
var. Swartziana Sydow.
Lithographa tesserata Nyl.
Opegrapha atra Pers.
Graphis elegans Ach.
Verrucaria aethiobola Wahlenb.
V. submersa Schaer.
V. maculiformis Krempelh.
Staurothele rupifraga Arn., Shap.
Arthopyrenia fallax Arn.
A. spilobola A. L. Sm.
A. submicans A. L. Sm.
Pyrenula nitida Ach.
Melanotheca gelatinosa Nyl.

REPORT ON THE MYCETOZOA FOUND DURING THE FORAY AT KESWICK.

September 15th to 21st, 1922.

By W. N. Cheesman, F.L.S. and W. T. Elliott, F.L.S., F.Z.S.

Rain is proverbial in the Lake District, and on our visit there was no exception to this for on most days it came down heavily and rendered the prospects unfavourable for obtaining Mycetozoa.

Most of the country visited consisted geologically of the Skiddaw slates and was clothed with a thriving vegetation, in contrast with that in which the volcanic Borrowdale series was dominant, where aridity, ruggedness, and destitution of growth were clearly apparent. The alluvial deposits in the fertile

valley connecting Bassenthwaite and Derwentwater appeared to be the most favourable hunting grounds for Mycetozoa, whereas the igneous rocks with a natural swift drainage, excessive wetness, and little depth of soil, may be regarded as unfavourable to their development. The arboreal vegetation was generally of small size and with very little undergrowth. Here and there a copse of hazel could be seen. The trees were mostly conifers, larch being predominant. Beech and oak occurred in a few places in the valley and the holm oak was well represented. Birch also was plentiful in places, particularly at the base of the hills, but elm was almost entirely absent.

In the following list of thirty-seven species it may be observed there is no record of Badhamia and that the prolific genus of Physarum is only represented by two species; most of these gatherings were deficient in lime. In the vicinity of the Falls of Lodore *Leocarpus fragilis* was taken in all stages of development. *Physarum viride*, *Trichia persimilis*, and *Trichia Botrytis* were also found here in quantity. The Trichiaceae are well represented in the list. It seems that the lime-forming species are not so happy in their development in these surroundings as is the case with the Trichiaceae and Arcyriaceae and those other species that are destitute of lime for it may be observed that the Calcarineae are represented by only eleven species in this list.

In the following list *T.* = Thirlmere; *L.* = Latrigg; *B.* = Borrowdale; *Ba.* = Bassenthwaite; *W.* = Whinlater and Wythop.

Ceratiomyxa fruticulosa Macbr., *B.*, *W.* A beautiful gathering in course of development had been entirely devoured next morning by the larvae of *Phronia basalis* Winn. a dipterous fly of the family Mycetophilidae. A species of Collembola also attacks it with avidity.

Physarum nutans Pers., *T.*, *B.*, *W.* (a slender form was taken in several places), var. leucopheum Lister, *B.* (this was taken in the valley).

P. viride Pers., *L.*, *B.*, var. aurantium Lister, *B.*

Fuligo septica Gmel., *T.* One gathering only.

Craterium minutum Fr., *B.*, *W.*

Leocarpus fragilis Rost., *T.*, *B.*, *Ba.* All gatherings had dark purple brown sporangia.

Diderma deplanatum Lister, *T.*

Didymium melanospermum Macbr., *T.*, nigripes Fr., *B.*, squamulosum Fr., *L.*, difforme Duby, *T.*

Lepidoderma tigrinum Rost., *B.* Developed from orange plasmodium found on damp moss near the Falls of Lodore, the accurately formed stellate scales attached to the sporangium wall in some cases were very conspicuous.

Stemonitis fusca Roth., *T.*, flavogenita Jahn, *B.*, *Ba.*

Comatricha nigra Schroet., *B.*, pulchella Rost., *B.*, laxa Rost., *B.*, typhoides Rost., *T.*, *L.*, *B.* (the stalk and cylindrical sporangia were devoid of the silvery outer growth).

Lamproderma columbinum Rost. var. iridescens G. List.*

Cribraria vulgaris Schrad., *B.*

Licea flexuosa Pers., *B.* Taken by Mr Knight shewing the outer mottled coat of refuse matter very clearly.

* See p. 32.

Reticularia Lycoperdon Bull., *B.*
Lycogala epidendrum Fr., *B.*, *W.*
Trichia affinis de Bary, *B.*, persimilis Karst., *T.*, *L.*, *B.*, *Ba.*, *W.* (all typical gatherings and very abundant), varia Pers., *T.*, *B.*, scabra Rost., *B.*, decipiens Macbr., *L.*, *B.*, *Ba.* (very plentiful), Botrytis Pers., *T.*, *L.*, *B.*, *Ba.* (the olive brown sporangia in abundance with lines of dehiscence well marked).
Arcyria incarnata Pers., *T.* (an almost sessile gathering was taken), denudata Sheld., *L.*, *B.*, cinerea Pers., *W.*, pomiformis Rost., *T.*, nutans Grev., *B.*
Perichaena corticalis Rost., *T.*

PRESIDENTIAL ADDRESS.

By F. T. Brooks, M.A., F.L.S.

SOME PRESENT-DAY ASPECTS OF MYCOLOGY.

The British Mycological Society may legitimately congratulate itself upon the impetus recently given to the study of mycology in this country, for its members have been largely responsible for the increased attention now given to this branch of botany. Under the able and energetic direction of the general officers, the Society has greatly increased its membership and has extended its activities with success, so that it is now a very vigorous body, meeting frequently in London or elsewhere, throughout the year. I am assured also that the efforts of the Society to assist in the mycological education of botanical students, especially in the field, are warmly appreciated. Another activity which has been supported by the Society is the establishment of a collection of pure cultures of fungi in the National Collection of Type Cultures at the Lister Institute, which, it may be hoped, will in time become the premier collection of its kind in the world. The recent establishment of the Imperial Bureau of Mycology under the directorship of Dr E. J. Butler is another indication of the importance which our subject has assumed in the Dominions and Colonies as well as at home. The publication by the Bureau of the "Review of Applied Mycology" is an event of special importance, and all mycologists are grateful for its appearance.

Mycology is a subject of wide scope, for fungi are aggressive organisms and play a by no means insignificant part in the economy of nature. Our branch of Botany has intimate connections with Cytology, Genetics, Protozoology, Medicine, Biochemistry, Plant Physiology and Plant Pathology. Indeed so close is the association between Mycology and Plant Pathology that the two are often identified in the minds of the scientific public, and although there are certain differences

between them, it is often impossible to say where mycology ends and plant pathology begins. A large part of the credit attributable to the recent progress in plant pathology, must undoubtedly be given to mycologists. During the past few years there has been a considerable influx of plant pathologists into the Society, and I trust it will ever be the aim of the Society to extend a warm welcome to all those scientific workers whose investigations require a knowledge of the life-habits of fungi for their solution.

Members of the Society have also recently been active in the publication of books upon fungi and allied organisms, and the reproach that there were no good modern British books on mycology is no longer valid. It is a pleasure to refer to the literary activity of several of our members: Miss Lorrain Smith's book on Lichens is the culmination of a life-study of this group, and will for many years be the standard work of reference upon these strange plants. Professor Dame Helen Gwynne-Vaughan's book on Fungi fills a much-needed want, and is a mine of information upon some of the most interesting groups. Within the last few months there has also appeared under the auspices of the British Mycological Society Mr Carleton Rea's book on "British Basidiomycetae." It must be a particular pleasure to Mr Rea, as it is to all of the members of the Society to see his monumental work in print, which will be a lasting tribute to his indefatigable zeal and skill in the study of the higher fungi. Mr Ramsbottom has revised the guide to the larger fungi in the British Museum and has provided therein a tale of the exciting adventures of toadstools and cup fungi which will not soon be exhausted. Finally Professor Buller has a second volume of his researches on Fungi on the point of publication, and we are all looking forward to reading the story of the new discoveries of the one who may be well called, without irreverence, the mycological magician. To each one of these authors the British Mycological Society will wish to offer its hearty congratulations.

In all these respects, members of the British Mycological Society have been active in promoting the study of mycology, and the liveliness in this subject which has arisen in consequence, augurs well for the future both of mycology and of our Society.

In the membership of our Society, there has been perhaps a greater influx of professional than amateur workers, and it may perhaps be feared by some that the interests of the amateurs may come to be overlooked. Speaking as a professional worker I trust that will never be. British mycology was fathered by an amateur, the Rev. M. J. Berkeley, and this Society was largely founded also by amateurs including Mr Cheesman and

Mr Carleton Rea, the latter of whom has been its guardian angel ever since. May I add that many of us academic workers owe a deep debt of gratitude to workers like Mr Rea who of their never-failing kindness help us persistently out of our systematic difficulties? I feel confident therefore that the mycological work of amateurs will be as warmly welcome in the future as in the past. The amateur is the salt of the earth, for it is he alone who is impelled to work by the love that is in him. Science is in danger of becoming over-professionalised, and it is only the spirit of the amateur that can preserve the freshness of outlook essential to the intellectual health of the professional investigator. At the last annual foray, the discussion initiated by Dr Butler indicated many of the ways in which amateur workers could be of assistance in promoting the study of fungi, and with the co-operation of both kinds of workers, British mycology has a rich harvest before it.

The Origin and Phylogeny of the Fungi.

I propose now to say a few words about the origin and phylogeny of the fungi. I know that in discussing this subject I am treading on dangerous ground, but I trust you will bear with me in my heterodoxy. I have just come from the meeting of the British Association for the Advancement of Science at Hull where there has been considerable discussion on the subject of Evolution. Anent this discussion Dr D. H. Scott made the remark that the day had passed when biologists thought they knew a great deal about the phylogeny of organisms; in his striking phrase, "phylogeny eludes us." This does not mean that nothing is known about the race-history of the main groups of animals and plants, but that we know far less than was thought only a few years ago. Notwithstanding this change in outlook there is still prevalent in the teaching of elementary botany a view of the origin and development of the fungi, to the exclusion of other possibilities, which I venture to combat. Besides, it is well occasionally to take a broad survey of the group of organisms with which we are dealing, for like all other students of detail, we are sometimes apt to miss the wood for the trees. The fungi are a remarkable group of organisms of which we, as mycologists, are rightly proud, but their unique characters are often overlooked, and many botanists look upon them as a race of degenerate organisms, poor anaemic creatures that have lost the power to photosynthesise. Let us examine this standpoint somewhat critically. Nowhere else in the plant kingdom is there an immense group which is looked upon as having been derived from green organisms by the loss of

chlorophyll. Where saprophytic or parasitic forms occur amongst green plants, their numbers are limited and diversity restricted, as if the loss of pigment and holophytic mode of nutrition had checked their evolutionary impetus. Thus the families of parasitic flowering plants, Orobanchaceae and Rafflesiaceae contain comparatively few genera and species, as if their undoubted degeneracy had brought the inevitable penalty in its train. Likewise the parasitic algae are few in number of species and infrequent in occurrence, pointing to the same truth that loss of a fundamental character leads inevitably to grave handicap in the struggle for existence. The fungi, on the other hand, rival the flowering plants themselves in number of species and diversity of form, and it is altogether against the laws of probability that they have been derived from such groups as the Green and Red Algae by the loss of pigment and development of a saprophytic or parasitic mode of nutrition. Thanks to the researches of Kidston and Lang* we now know that the fungi are at least as old as the Devonian rocks, and it is likely that they date back to that far distant time when the chief groups of lower organisms were becoming differentiated after the dawn of life in the primitive ocean. With their infinite variety, the fungi must have possessed some of that evolutionary driving power which was inherent in the organisms that gave rise to the dominant groups of plants and animals. It has been suggested by Church† that the growth-forms of the fungi, including the lichens, are essentially those of marine algae, and he apparently denies to the group any really independent power of form development. For instance he states‡ that "a higher fungus of the land is in short a skinned seaweed, implying a more or less elaborated algal growth-form, in which in the death and decay of the older metabolic and autotrophic surface layers, the exposed internal heterotrophic tissues continue their heterotrophic existence at the expense of the soluble carbohydrates of the standing and non-aerated medium." Where for instance amongst the algae will be found the growth-forms of *Xylaria*, *Polyporus squamosus*, the common mushroom, or finally of the elegant *Dictyophora*s of the Gasteromycetes? It must not be forgotten that in the higher fungi the conspicuous part is essentially a spore-producing structure which cannot be directly compared with the somatic equipment of the algae.

Church's view is that the fungi have been derived from transmigrant algae by the loss of chlorophyll, such algae being

* Kidston, R. and Lang, W. H. On Old Red Sandstone Plants showing structure, etc. Part v. Trans. Roy. Soc. Edin. LII, p. 855 (1921).

† Journal of Botany, p. 41 (1921).

‡ Church, A. H., Thalassiophyta, p. 59, etc., Oxford (1919).

of a much more generalised type than marine forms at present existing. This is an interesting speculation, but it is not more than a speculation, and even if an agnostic attitude be adopted in regard to it, most mycologists will combat the idea that the fungi, thus derived, possess little or no novelty in form-development.

Although Church's view that fungi have arisen from trans-migrant algae is unsatisfying, even more problematical is the outlook, still prevalent among botanists, that the fungi have been derived from algal forms somewhat similar to existing types of Green and Red Algae. This is a reflection of the views of Pringsheim, de Bary, and Sachs, especially of the last named. It may be remembered that Pringsheim actually placed *Saprolegnia* amongst the green algae, as a colourless form. Since the lifetime of these botanists, however, further research has thrown a flood of new light upon the fungi, which makes much more problematical the correctness of their views. It is a commonplace of botanical lecturers to compare *Pythium* with *Vaucheria*, and *Mucor* with *Spirogyra*, and the comparison is not infrequently accompanied by more than a suggestion that the forms may be phylogenetically connected. Again, the Ascomycetes and the Rust Fungi are commonly connected with the Red Algae, in the main, apparently on account of the presence of trichogynes and spermatia. In my opinion the resemblances between these groups of algae and fungi are entirely superficial, and are of no phylogenetic significance whatever. If the comparison is pressed for instance between *Pythium* and *Vaucheria*, enormous differences are found between the two forms; for instance the mode of germination of the zygote, a character probably of considerable ancestral importance, is different, and the characters of the ciliated cells are so diverse that a phylogenetic connection seems out of the question*. It is even more difficult to conceive of a phylogenetic comparison being drawn between *Mucor* and *Spirogyra*, and the sooner such is relegated to the limbo of forgotten things, the better for botanical clarity of vision. As between the Ascomycetes and the Uredineae on the one hand, and the Red Algae on the other, the comparison is usually of a more delicate nature, but it seems equally fallacious. The comparison between the trichogynes of the respective groups can hardly be taken seriously for there are great structural differences between them, while in sexuality

* Since delivering this address, Dr Butler has reminded me of his paper "On *Allomyces*, a new aquatic fungus" (Annals of Botany, xxv, p. 1123, (1911), in which this curious genus of the Leptomitaceae is compared with the algal genus *Dichotomosiphon*. Although the resemblance between the growth forms of these two genera is striking, the profound differences in reproduction appear to me to invalidate any phylogenetic connection between them.

and in nuclear cycle, the differences are profound. Again, the argument is often advanced that in certain groups of existing algae, the phenomenon of parasitism exists, accompanied by the partial or total loss of chlorophyll, as in *Harveyella* and *Chroolepus*, and that this illustrates the way in which fungi have arisen. Although these forms have wholly or partly lost their chlorophyll they still reproduce in a purely algal manner and show no approach to a fungoid nature. Now it is a general belief, and probably a correct one, that parasitism in the fungi is a more recent development than saprophytism. Saprophytic algae are exceedingly rare and show even less approach to mycelial growth than do the parasitic forms. Saprophytism and parasitism in the algae at the present day are exactly the same phenomena as the occasional adoption of these modes of nutrition in other holophytic groups, and have no significance as regards the origin of the fungi, the peculiarities of which must be sought elsewhere. If the fungi had been derived from algae by the loss of chlorophyll, one would expect to find in certain fungal forms at any rate, traces of the same type of carbohydrate metabolism as that existing in the algae. Such in point of fact does not occur, and an entirely different set of carbohydrates is found in the fungi.

The almost universal hyphal development of the fungi is sometimes compared with the filamentous nature of many algae. In most groups of algae, the filamentous types pass over into more complex forms in which longitudinal divisions of the cells occur, and, in the higher forms of algae, tissues are present closely similar in character to those of terrestrial green plants. On the other hand, even in the most highly developed fungi, longitudinal divisions of the cells are almost unknown, and the tissue systems are of a type unique in the plant world. Here again there is a great gulf fixed between the algae and the fungi. If the two groups had been phylogenetically connected, the higher fungi would probably have exhibited some of the types of cell aggregation prevalent in the holophytic algae. The hyphal development of the fungi can be looked upon as a pronounced type of cell expression, potentially present in all living cells, which has been developed to an extreme degree in correlation with peculiar modes of nutrition. Whenever a somatic part of an organism with an essentially absorbent function is embedded in a nutritive medium, be that dead or alive, there is a tendency to a hypha-like type of growth, as, for example, in the rhizoids and root hairs of green terrestrial plants. Again the growth of a pollen tube in the tissues of the style is essentially hypha-like, and the vegetative body of the Rafflesiaceae, a parasitic family of flowering plants, is practically a mycelium. Even in animal

cells, this tendency to hypha-like proliferation in response to a peculiar environment is of common occurrence, as for example in cartilage tissues grown aseptically under artificial conditions. As regards the latter, the parallel is so close to the growth of a fungus mycelium that a friend who was investigating the growth of animal tissues under cultural conditions, at first thought that his cultures had become contaminated by a fungus; the hypha-like threads were in fact nothing but proliferating cartilage cells. Thus the mycelial character of the vegetative body of most fungi must be looked upon as a type of cell development elaborated in connection with special nutritive needs, and not in any way as being mainly the expression of an algal ancestry.

Another marked difference between the fungi and the algae, and indeed all other groups of green plants, lies in the chemical composition of the cell membranes. It has long been known that the cell walls of fungi differ chemically from the cellulose which is the chief constituent of the cell walls of other plants. At first the main constituent of hyphal walls was called "fungus-cellulose," but more recently it has been shown that this substance contains nitrogen whereas true cellulose does not, so that it differs markedly. The main constituent of fungal walls resembles in many ways the chitin of animal cells. Recent investigations tend to emphasise the phylogenetic significance of the chemical constitution of cell membranes, and it seems clear that if the fungi had been derived from the algae there would be closer approximation in the characters of the membranes. For instance, the chemical differences between the cell walls of *Pythium* and *Vaucheria* make it certain that an immense gap lies between them, apart from all other considerations. While mentioning chemical differences between fungi and other plants, it may be pointed out that many fungus pigments are highly peculiar, especially those of the lichens. On the other hand most of the pigments of green plants show close relationships to one another.

With these profound and fundamental differences between the fungi and the algae it may not be unprofitable to consider in some detail the view which has been put forward by Dangeard* and others that the origin of the fungi is to be sought in unicellular protist organisms. Dangeard has had a unique experience as an investigator of the lower forms of life, both plant and animal, and his views are entitled to most serious consideration. In the main I am in harmony with him although I cannot agree with some of his deductions. At the bottom

* Dangeard, P. A., Les ancêtres des champignons supérieurs. Le Botaniste, IX, p. 157 (1903).

of the plant and the animal kingdoms there are large numbers of forms which in some respects show plant characteristics and in others, animal characteristics, *i.e.* are intermediate between the plant and animal kingdoms, as well as innumerable other types which, though predominantly plant or animal-like, can scarcely be regarded as definitely one or the other. The Flagellata, the Mycetozoa, and the Bacteria are groups of this class. Some of the Flagellata are intermediate in character between plants and animals, while others possess almost exclusively animal characteristics. The Mycetozoa are predominantly animal-like in one phase of their existence, and plant-like at another, while the Bacteria are chiefly plant-like throughout their development. Whatever view is taken of the origin of protoplasm, *i.e.* of life on this planet, it is clear, from what is known of evolutionary processes, that at the dawn of life the forms were probably very few, perhaps only one, possessing a mode or modes of nutrition conceivably different from those of the great majority of plants and animals of the present day. Certain forms of bacteria obtain their essential supplies of nitrogen and carbon even now by ways which are neither like those of typical plants nor animals. It is possible, therefore, that the earliest forms of life were generalised types, neither definitely plants nor animals, perhaps possessing peculiar prototrophic modes of nutrition. I mention this possibility as it is sometimes postulated that plant forms must have preceded the evolution of animal organisms. Now it is likely that long before organisms possessing tissue systems had become differentiated, the chief groups of the Protista had come into existence, so that there was no lack of organisms of a saprophytic mode of nutrition available in the sea at the time when the larger seaweeds were being evolved. It is less difficult to conceive of the direct evolution of such unicellular types into forms with hyphae as a response to continued possibilities of existence in vegetable and animal debris, than it is to suppose that the fungi have in the main been evolved directly either from transmigrant algae, or from Green and Red algae somewhat similar to existing types. The fungi undoubtedly possess some of the initial, evolutionary impetus characteristic of all the primary groups of living organisms, which they hold by virtue of an early differentiation from protist organisms.

One of the difficulties encountered by those who derive the fungi from the algae is to account for the Chytridiineae from an algal ancestry. There are few algae to which these peculiar fungi can be even remotely associated, and the group contains several families of great diversity. The simplest types are approximately spherical with no attempt at proliferation, but other forms

show the initiation of hyphal development. Dangeard*, Atkinson† and others who have worked much on the lower forms of life have suggested a connection between the Chytridiineae and certain groups of the protozoa, and there are many points of contact between the two, both as regards cytology and ontogenetic development. Wager‡ called attention to certain protozoan similarities in his investigation of *Polyphagus Euglenae*, and the recent account of the cytology of *Synchytrium endobioticum* by Curtis§ also shows points of resemblance. The absence of cell membranes in many Protozoa is often held to discount the connection between fungi and protist organisms, but large numbers of Protozoa possess well-defined membranes by no means exclusively in the encysted condition, while some fungi are devoid of walls in certain phases of their existence. Thus some of the Foraminifera possess chitinous membranes, and many Radiolarians, Heliozoans and Ciliates have well-defined walls, while in the lower fungi certain stages of the life-cycle are devoid of membranes, and in *Synchytrium endobioticum* the organism is entirely devoid of a wall until a somewhat late stage in development.

Apart from the confusion that formerly existed between certain Chytridiineae and Monads, some organisms are with difficulty classed in the Protozoa or the Chytridiineae, *e.g. Rhinosporidium*‖ in the Haplosporidia, just as there are some types, *e.g. Sappinia pedata*, which may be a connecting link between the Protozoa and the Mycetozoa. Again, the Chytridiineae show marked differences from one another as regards sexuality, but all sexual processes within the group are of a relatively primitive nature and some of these are closely similar to processes of fusion in the Protozoa. The sexuality of the fungi is often looked upon as a residuum, as it were, of the sexual processes existing in the algae. It seems much more reasonable to conclude that like other groups of organisms, both in the plant and in the animal kingdoms, they have initiated their own sexual processes which have been evolved along unique lines in correlation with peculiar environmental conditions. With the development of special methods of reproduction, with the initiation of sexuality, and with the beginnings of hyphal formation, we may see justification for including, as does

* Loc. cit.

† Atkinson, G. F., Some problems in the evolution of the lower fungi. Ann. Myc. VII, p. 441 (1909).

‡ Wager, H., The life-history and cytology of *Polyphagus Euglenae*. Ann. Bot. XXVII, p. 173 (1913).

§ Curtis, K. M., The life-history and cytology of *Synchytrium endobioticum* (Schilb.) Perc. etc. Phil. Trans. Roy. Soc. CCX B, p. 409 (1921).

‖ Prof. J. H. Ashworth in his recent paper on *Rhinosporidium Seeberi* refers this genus to the Chytridiineae (Trans. Roy. Soc. Edin. LIII, p. 301 (1923)).

Lotsy* the Chytridiineae in a primitive group the Archimycetes from which other groups of fungi may be held to have arisen.

In certain members of the Oomycetes and Zygomycetes, the atypical development of the hyphae must have struck everyone. With forms like *Phytophthora* in particular, the hyphae often become vesicular, even under normal conditions, and appear strangely unlike hyphae of the higher fungi. In a new genus (*Caeolomomyces*) recently described by Keilin†, which has a more marked mycelial development than in other Chytridiineae although in most respects it appears to belong to this group, the hyphae are particularly wide and irregularly swollen, and show an intermediate condition between a vesicular and a hyphal mode of development. These aberrant hyphal forms may be the expression of an ancestry from non-hyphal types, such as protozoal or other protist organisms.

There are forms also which are classed with difficulty either as bacteria or as fungi, as *e.g.* species of *Actinomyces* and *Streptothrix*, and the possibility of connection between the higher bacteria and the fungi must not be overlooked, although it is more likely that the relationship is not of a direct nature.

The outlook of the writer upon the fungi is therefore that it is an enormous group of organisms of extreme age and probably of protist origin, which has developed upon independent lines, and which shows the same kind of differences between its constituent divisions as do other large phyla of plants and animals. Theories of evolution are again in the melting pot, and although the facts of evolution are not in dispute, there seems to be more uncertainty than ever as to the manner in which it has been brought about. By some authorities the fungi are considered to be of polyphyletic origin and some who hold to the protist or Chlorophycean origin of the lower fungi, deny this to the higher fungi, deriving the latter from the Rhodophyceae. However little is known about the origin of the fungi, we are equally ignorant of their phylogeny. But if a totally different origin for the lower and the higher fungi be postulated there is evidently a great gap between the Phycomycetes and the Ascomycetes, which is unbridgeable. Now there are sufficient similarities between the Ascomycetes and the Phycomycetes to nullify the hypothesis that there is no conceivable connection between them. By no great stretch of the imagination a form such as *Pyronema confluens* may conceivably be derived from *Albugo Bliti*, although I do not wish to imply that this may actually have happened. Although Brefeld's old group of the Hemiascomycetes will not stand the

* Lotsy, J. P., Vorträge über botanische Stammesgeschichte, Jena (1907).

† Keilin, D., On a new type of fungus: *Caeolomomyces stegomyiae* n. g., n. sp., etc. Parasitology, XIII, p. 225 (1921).

test of enquiry, there are undoubtedly forms such as *Dipodascus* which tend to link the Ascomycetes with the lower fungi. As regards the difference between the non-septate hyphae of the Phycomycetes and the septate hyphae of the Eumycetes, this is often unduly emphasised. Many Phycomycetes are not infrequently septate, *e.g. Spinellus* in the Mucorineae, especially when the hyphae are old, while in the higher fungi, hyphae frequently remain unseptate during active growth. I would suggest rather that the Ascomycetes were evolved from the lower fungi at some far distant time, long before the present forms of the Phycomycetes existed. The Ascomycetes are clearly of one origin, for the structure of the ascus is so uniform throughout the group that it is inconceivable it could have arisen polyphyletically. Church homologises the ascus with the spore mother cells or tetrasporangia of marine algae. The ascus is clearly a spore mother cell, but to grant this does not imply the phylogenetic connection which Church appears to indicate. Wherever sexuality occurs, reduction in the number of chromosomes must necessarily follow, this being most readily achieved by nuclear divisions in a mother cell. Just as the fungi are held to have developed along their own sexual lines, so the spore mother cells or asci in the Ascomycetes, are the necessary counterpart of sexual processes. The peculiar development of ascogenous hyphae with their ultimate formation of asci, is a means of enormously increasing the spore output in relation to sexuality and in correlation with special modes of dispersal and nutrition involving tremendous wastage of reproductive units. Again, the basidium of the Basidiomycetes is often held to have no relationship with the ascus. On the other hand the basidium is essentially the same cytologically as the ascus. In both there is a fusion of nuclei followed by a reduction in the number of chromosomes. There are usually three nuclear divisions in the ascus and two in the basidium, but Juel* has recently demonstrated the existence of more than two divisions in the spore mother cells of many Basidiomycetes. In my opinion the basidium can be held to have been derived from the ascus in correlation with a different type of spore discharge. Buller† has shown that the spores of many Basidiomycetes are violently ejected from the sterigmata. Now whereas in most Ascomycetes each ascus ejects all its spores simultaneously, in the Basidiomycetes each spore is discharged separately from the basidium. If the process of spore formation of a basidium

* Juel, H. O., Cytologische Pilzstudien, I. Die Basidien der Cantharellus, Craterellus, und Clavaria. Nov. Act. Reg. Soc. Sc. Upsala, ser. IV, iv, no. 6 (1916).

† Buller, A. H. R., Researches on Fungi, II. Longmans and Co., London (1922).

is considered in detail, although the differences between basidiospore and ascospore formation are considerable, these are not so profound as might be thought at first sight. The divergence in method of spore formation and spore discharge between the Ascomycetes and the Basidiomycetes is correlated with diversities in style of architecture, but in both groups the spore mother cells are fundamentally the same and are often multiplied indefinitely to provide for an enormous spore output.

The Uredineae and Ustilagineae are peculiar groups of obligate or semi-obligate parasites which show no close relationship with other Basidiomycetes, but which undoubtedly fall within this category. The Uredineae in particular exhibit considerable resemblance to the Ascomycetes. No one who has worked on the cytology of such forms as *Gnomonia*, *Polystigma*, or the lichen fungi can fail to be impressed by their likeness in certain respects to rust fungi. The spermogonia of both and certain features in the development of aecidia and perithecia show a marked resemblance, which may point to ancestry from a common stock or may be of even greater phylogenetic significance. The similarity between certain Ascomycetes and the rust fungi was commented upon by de Bary* many years ago, and I ventured to call attention to it in a paper on *Gnomonia erythrostoma* published in 1910†. The gap between the Basidiomycetes and the Ascomycetes is not unbridgeable, and a common origin for both groups is indicated. The divergence between them is of long standing, and may date back to the time when they, together with early forms of the Phycomycetes, began to be evolved from the first organisms of a definitely fungoid nature. It may be mentioned here in passing that there is much to be said for separating the Smut and the Rust Fungi from all other basidia-producing fungi, and constituting them a group of equal rank with the Ascomycetes and the remainder of the Basidiomycetes.

It is maintained, therefore, that the fungi are a monophyletic group, established in far-distant times from protist organisms, which have evolved along their own lines just like any other large group of plants or animals. In the past a polyphyletic origin for many groups of organisms including fungi has been advanced, but the present trend of opinion is in favour of attributing each phylum to a common ancestry, notwithstanding the existence of great discontinuity of type within the phylum. It is admitted that it is particularly difficult to trace relation-

* de Bary, A., Comparative morphology and biology of the fungi, mycetozoa and bacteria. English translation (1887).

† Brooks, F. T., The Development of *Gnomonia erythrostoma* Pers. Ann. Bot. XXIV, p. 585 (1910).

ships amongst the fungi, largely because their vegetative characters, being almost valueless as a criterion of relationship, cannot be used as in other plants and animals, to supplement comparisons of reproductive organs.

All workers on evolution have been struck by the marked discontinuity of character both between different groups of organisms and also within each group. This discontinuity is one of the most marked features of living organisms, and it is just as much exemplified in the fungi as in other groups of organisms, but there is no more reason for supposing that the liverworts have arisen from several different sources than that the fungi have been so derived.

Thus as against the opinion that the fungi are organisms which have come directly from the algae by the loss of photosynthetic power, arguments have been advanced in favour of the view that the forms from which they came never possessed this power. Organisms which lose such an important character as chorophyll are invariably strictly limited in their power of development, whereas no group of organisms shows more diversity of species than do the fungi. The fungi, possessing some of the original impetus of primitive life, have evolved along their own lines, and have achieved entirely novel types of reproductive mechanism. To elaborate a new style of architecture is not the mark of a decadent civilisation, and the fungi having achieved so much that is unique in the plant kingdom cannot be looked upon as a degenerate race. When the fungi are spoken of as an insignificant race with no power of independent development, I am reminded of a book I read in boyhood, namely, Jules Verne's "Journey to the centre of the earth." It will be remembered that, with the novelist's imagination, he represents the voyagers in the interior of the earth as having to traverse a gigantic mushroom forest where fungi had achieved an arborescent habit of growth. Jules Verne at any rate was alive to the possibilities of fungi, and his outlook is to be preferred to that which holds the group to be devoid of initiation and crippled by degeneracy.

The Relation of Mycology to Plant Pathology.

As most plant diseases are caused by fungi, the relation of mycology to plant pathology is clearly of great importance. An accurate knowledge of pathogenic fungi is indispensable to anyone who attempts to deal with the more general aspects of disease in plants or with its control. Mycology is one of the foundation stones of plant pathology, and indeed Berkeley and de Bary, both eminent mycologists, were the real founders of

the serious study of disease in plants. Just as plant physiology is dependent in part upon systematic botany, so is a knowledge of the fungoid diseases of plants dependent upon systematic mycology for accurate treatment. Whenever one branch of knowledge is intimately connected with another there is usually a mutual reaction of the one upon the other and I trust that plant pathology will be not without influence on systematic mycology. Persons who investigate plant diseases often encounter difficulties in the identification of the pathogen which can only be solved with the aid of the systematic mycologist, and I should like to acknowledge here the great assistance received in my own work from systematic mycologists. But the plant pathologist is often avaricious in his desire for information, and sometimes the particular knowledge he requires from the systematic mycologist is not at present available. The plant pathologist is accustomed to growing pathogenic fungi in pure culture whenever possible, where their behaviour can be followed under carefully controlled conditions. In this way he gets an idea of the range of variability of a species which is often at variance with its formal diagnosis and with that of allied forms. Thus the innumerable forms of *Cladosporium* which have been described in systematic works are meaningless to the plant pathologist, for he finds by experience that they can all be grouped around a few types which are the real units. It is clear that species must be diagnosed upon the basis of characters shown on natural substrata, but the time has come when these descriptions should be supplemented by an accurate account of their behaviour upon standard media under controlled conditions wherever the forms can be readily cultivated. To diverge for a moment; this mode of treatment has become an urgent necessity for the moulds as shown by Thom in the genus *Penicillium* and by Lendner in the Mucorineae, and the time can be foreseen when biochemical reactions will be of fundamental importance in differentiating such types. It may be remarked that it is merely a platitude to urge supplementary descriptions of the species as grown in artificial culture, but it is important to reiterate this necessity, for few systematic mycologists yet realise its significance.

Again, with parasitic genera like *Ramularia, Ovularia, Gloeosporium*, etc., the diagnosis of species is unsatisfactory to the worker on plant diseases. The chances are that if either of these forms is found on a new host, a new species will be created without adequate comparison with existing species. Shear and Wood* have shown that many species of *Gloeosporium* hitherto

* Shear, C. L. and Wood, A. K., Studies of fungous parasites belonging to the genus *Glomerella*. U.S. Dept. Agric., Bureau of Plant Industry, Bull. 252 (1913).

considered distinct are really identical, and it is unquestionable that there should also be a considerable elimination of species in other genera. In parasitic genera of this kind it is only by cross inoculations that proper host relationships can be discovered, so that it is urgent here for the systematist either to become a pathologist for the time being or to work in close co-operation with one. Species diagnosis must at present be primarily based upon structural characters, and however useful physiological characters may be for the separation of distinct strains, physiological differences alone cannot yet be taken as adequate criteria for species differentiation. In many pathogenic fungi there is exhibited the phenomenon of specialised parasitism, *i.e.* the existence of a number of forms differing in host relationships but either only slightly or not at all in structure, within the limits of a single species as ordinarily understood. This phenomenon is particularly well shown in *Puccinia graminis* which comprises many forms of distinct physiological relationship such as the variety *Tritici* confined almost entirely to wheat, and the variety *Secalis* upon rye, couch grass, and a few other grasses. Prof. Stakman of America has recently told me that some of these physiological varieties in America show slight structural differences, for example, in the dimensions of the uredospores and aecidiospores. If these structural differences were more considerable, there would be a strong claim for converting these specialised races into distinct species. In systematic work there will always exist, both the "lumper" and the "splitter," for in the main it is a matter of opinion as to what degree of difference constitutes specific differentiation. To the plant pathologist it does not much matter whether the species have been diagnosed by a "lumper" or a "splitter" as long as the basis of distinction is clearly set forth in language that he can understand. I must confess a preference for the methods of the "lumper" for, as stated in another place*, mycological systematy will become altogether too unwieldy if fungus species are set within too narrow limits.

Another difficulty encountered by the plant pathologist is that even the generic limitations hitherto imposed by systematists not infrequently break down in practice. In the Fungi Imperfecti in particular this difficulty is often met with, and it was pointed out a short time ago in dealing with certain tomato diseases* how the generic distinctions between *Phoma*, *Phyllosticta*, *Ascochyta* and *Diplodina* broke down. There cannot be any doubt but that many genera in this group are entirely artificial, and one looks forward to the time when some systema-

* Brooks, F. T. and Searle, G. O., An investigation of some tomato diseases. Trans. Brit. Myc. Soc. VII, p. 191 (1921).

tist will have the courage to eliminate many of these so-called genera, or establish a more adequate classification.

No branch of systematic botany should be divorced from the study of living plants, and just as those who classify flowering plants cannot but be assisted in their labours by following the work of geneticists and by watching the behaviour of the living plants under different environmental conditions, so, I think, it will be of advantage if systematic mycologists will actually grow certain groups of fungi under artificial conditions and will keep in intimate touch with plant pathologists. An instance of the lack of co-operation between fungal systematy and plant pathology is afforded by the separation of the species *Stereum rugosiusculum* from *Stereum purpureum* by Burt*. This distinction is supported by Rea in his "British Basidiomycetae." *Stereum purpureum* is the primary cause of silver-leaf disease of fruit trees in this country, and has hitherto been held to include the form *rugosiusculum* now separated by these authorities. Since Burt published his monograph on the genus *Stereum* I have examined many collections of this fungus from different substrata, and as far as investigation has proceeded, the chief distinction between the two species according to Burt, namely the presence of hymenial cystidia in *rugosiusculum* and not in *purpureum*, seems to be an inadequate criterion. In none of the specimens have the cystidia been so abundant as figured by Burt for *rugosiusculum*, but, apart from this, there has been every possible intergrade between forms possessing many hymenial cystidia and forms devoid of them. Indeed, within the limits of a single sporophore there are great differences in the distribution of these hymenial hairs. From the pathogenic standpoint I believe *S. rugosiusculum* and *S. purpureum* are one, and with all deference to Burt and to the author of "The British Basidiomycetae," I think doubt must remain as to whether *S. rugosiusculum* is a valid species until more adequate evidence is forthcoming as to its structural peculiarities. *S. purpureum* and *S. rugosiusculum* would probably never have been separated if the systematist had co-operated with a plant pathologist.

There are innumerable other relations between mycology and plant pathology, but only the briefest reference can be made to these. The day has passed when it was considered sufficient in investigating a plant disease of parasitic origin to determine the causative agent. Nowadays that is merely the beginning of a new series of investigations to elucidate precisely the conditions under which the pathogen can effect an entrance into the host, the exact mode of penetration, and the relationships

* Burt, E. A., The Thelephoraceae of North America, XII. Ann. Missouri Bot. Gard. VII, p. 127 (1920).

existing between the parasite and the surrounding tissues. Mycology therefore must be directed towards the study of the physiology of fungi as well as towards their morphology. Plant pathology is essentially abnormal plant physiology, in which a parasite is often the disturbing agency. Acting upon both host and parasite are environmental conditions which sometimes favour the one and sometimes the other. As Butler has indicated in his "Fungi and Disease in Plants" these external factors are often of critical importance in the establishment of disease. Several mycologists are now engaged upon an intensive physiological study of certain pathogenic fungi, and already at the hands of Brown, Wiltshire, and others, results of great importance have been obtained. For several years I have been engaged upon an intensive study of *Stereum purpureum*, and with the help of my colleagues, light is now being shed upon the exact manner in which this fungus causes infection of fruit trees. In the study of fungous diseases of plants, so many factors are involved that it is often supremely difficult to determine their relative importance, but it is certain that unless the physiology of the parasite be studied in detail, no considerable progress will be made in the fundamental elucidation of disease.

The Training of Mycologists and Plant Pathologists.

On this occasion it may perhaps be opportune to say a few words about the training of mycologists and plant pathologists. As regards training, it is hardly worth while to draw a distinction between mycology and plant pathology, for although there are important differences between the two classes of work in some spheres of activity, from the point of view of the men who are trained to occupy technical posts of this nature in various parts of the Empire, the work of most mycologists is essentially plant pathology, *i.e.* the investigation of plant diseases and their control. It is important to consider this matter carefully, because in distant parts of the Empire the mycologist is often a person of no mean importance; he has often been the first scientific officer to be sought by the cultivator on account of disease becoming a serious menace. If the mycologist sent out has been a suitable man and has been of assistance to the plant industry which invoked his aid, his success has often led to the formation of extensive agricultural and botanical departments which have become active centres of research and guidance in the many diverse branches of tropical agriculture.

In my opinion the mycologist must be essentially a botanist. Just as a doctor must be thoroughly familiar with all parts of

the human body so must the mycologist have a broad training in the general principles of botany, and apart from a special knowledge of fungi, his mind must be imbued with the importance of plant physiology. Without a clear insight into plant functions, a mycologist will often fail to see the most important aspects of disease in plants. With plant physiology of such great significance, the botanist who is going to become a mycologist must have received an adequate training in chemistry and physics, for without these foundations, the biologist in general and the mycologist in particular will be severely limited unless his work happens to be of an entirely morphological nature. By this emphasis upon the study of chemistry and physics even for the mycologist, I do not wish to minimise the importance of the study of natural history. Many of us, myself included, were led into scientific studies through the naturalist instinct, and for training in observation and discrimination there can be no finer introduction than the cultivation of this instinct. For the plant pathologist, the outlook of the naturalist is a splendid asset, but by itself it is not enough for the solution of the intricate problems of plant disease. Our young mycologist then should be a trained botanist with a physiological outlook and with the instinct of the naturalist perhaps in addition. He may now proceed to obtain a wider acquaintance with fungi and plant diseases, and may perhaps take short courses in bacteriology and entomology. Even then his training in my opinion will fall short of what is desirable. At this stage he may go abroad and take up a post as mycologist and plant pathologist. If he has been living in contact with the land his outlook upon the plant industry he has been sent to aid will probably be sound, but if he has not been brought into contact with growing crops, he will be gravely handicapped in dealing with diseases of economic importance. He may be supremely expert in laboratory investigation, but may utterly fail when brought into contact with a practical problem, because a sense of crop values has never been inculcated in him. Cultivators sometimes make the complaint that the remedy is worse than the disease, but where such remedies are suggested, they are always based upon ignorance of crops and their economics. Again as already indicated, the influence of environment as a serious factor in the causation of plant disease is of immense importance, and unless the investigator has his attention fixed upon all aspects of the crop, as well as upon the pathogen, his efforts will often be doomed to failure. I suggest, therefore, that during the later stages of his training, the embryo mycologist be given some familiarity with the growth of crop plants, especially as regards the influence of cultural and climatic

factors upon them, and also as regards crop values. It is not necessary to attend formal classes in agriculture to get the requisite point of view, and in many ways the proper outlook is best inculcated through practical instruction in the field by a competent plant pathologist. It may be thought that I have outlined an ideal impossible of accomplishment; I do not think so, and having had considerable experience in the training of mycologists, I have not suggested more than is actually attainable in practice. I have ventured to place this matter before you, because there is a tendency in some quarters to divorce mycology and plant pathology from botany. That I am sure is a profound mistake, and I trust that any tendency in that direction will be resisted to the uttermost in this country.

LAMPRODERMA COLUMBINUM ROST. AND ITS VARIETIES.

By G. Lister, F.L.S.

Lamproderma columbinum (Pers.) Rost. is in its typical state a beautiful and well-marked species. It is distinguished by having ovoid or globose iridescent sporangia on long stalks; dark capillitium radiating from a cylindrical columella and composed of acutely branching threads which end in slender colourless branchlets, and form a dense brush or pile at the surface. The spores are dark purplish-grey, closely spinulose, and 11 to 14μ in diameter. This is the usual form, appearing on dead coniferous wood, and widely distributed in temperate regions.

Two other forms, connected with the typical one by gatherings intermediate in character, and having typical spores, occur on moss or wet rocks, on Sphagnum, and less frequently on fir wood.

One, which may be named var. *brevipes*, is not infrequent in this country, and probably on the continent also. The globose sporangia have short and often slender stalks, 0·7 mm. or less in height; the capillitium in some instances can hardly be distinguished from that of typical *L. columbinum*, but is usually less dense; in other examples it consists of purplish mottled threads, tubular and flattened near the base, branching repeatedly and becoming very slender above where they anastomose to form an irregular network; in some developments a curious knotted effect is produced by the presence of dark broad expansions in the axils of some of the branches.

This variety has been obtained many times in a wooded

ravine near Llanymawddwy, North Wales, by Lady Bradford and myself, from Hexham by Miss E. K. Higgins, from Porlock by Mr N. G. Hadden, from Keswick by Mr W. N. Cheesman, from Aberdeenshire by the Rev. W. Cran, from near Berlin by Dr Jahn, from the Vosges mountains by M. Demange and from the Jura by M. Ch. Meylan*.

The other form has globose sporangia, with either long or short cylindrical stalks, and rather lax flaccid colourless capillitium. A specimen of this having almost sessile sporangia, gathered by Richard Spruce in the Pyrenees in 1851, was named by Berkeley *Physarum iridescens*†, and by Rostafinski *Lamproderma iridescens*‡. It has been found several times in North Wales, usually with long stalks and associated with var. *brevipes*. In the field it has the aspect of typical *L. columbinum* of which it is apparently a weak development. A feature suggesting weakness is that the stalks are not solid below but enclose a loose sponge-like network of interwoven strands.

In both editions of the British Museum Catalogue of Mycetozoa this form is included under *L. columbinum* var. *sessile* Lister. The variety was established to cover an assemblage of doubtful specimens, two of which have proved to be new species belonging to entirely different genera, namely *Diachea cerifera* G. Lister and *Leptoderma iridescens* G. Lister. It would seem well therefore to drop the name *sessile*, and restore Berkeley's name *iridescens* for the variety of *L. columbinum* with colourless capillitium.

The colour of the plasmodium in this species is usually watery-white, but it may also be opaque-white or yellow. Miss A. M. Davidson writes that in woods near Aberdeen she has observed the form with obovoid sporangia maturing from watery-white plasmodium "nearly fifty times," and less frequently globose sporangia maturing from opaque-white plasmodium, "like a streak of white enamel paint." Another specimen from the same woods, approaching var. *brevipes* in capillitium, had "canary yellow plasmodium"; the var. *brevipes* from North Wales and Keswick had watery-white plasmodium; typical ovoid sporangia sometimes have plasmodium of a dull yellow colour.

M. Ch. Meylan has described a new species, *L. Cruchetii*§, from specimens found on Le Chasseron, Jura Mountains, on

* It is probable that *Lamproderma Staszcii* Raciborski (Hedwigia, vol. 28, p. 116 (1886)) from the Tatra Mountains, "Poland," may be an extreme form of var. *brevipes*. The sporangia are described as violet-black, on very short stout stalks, with broad flattened capillitium threads, 30μ wide below, dichotomously branched and narrowing above till towards the surface they are very slender; spores 12·5 to 15μ.

† Hooker's Journal of Botany, III, p. 20 (1851).

‡ Monograph of Mycetozoa, Appendix, p. 25 (1876).

§ Bull. Soc. Vaud. Sc. Nat. no. 52, p. 96 (1918).

dead fir wood. The globose sporangia have stalks 1 mm. high or less, and capillitium closely resembling that of *L. columbinum*. M. Meylan lays emphasis on the colour of the plasmodium having been yellow, but as yellow plasmodium occurs sometimes in *L. columbinum*, it may be found that *L. Cruchetii* is a form of that species approaching var. *brevipes*.

In conclusion the two varieties above referred to may be defined as follows:

var. **brevipes**. Sporangia globose; stalks short, usually slender; capillitium of purplish threads, tubular and flattened below, slender and forming an irregular network above.

var. **iridescens**. Sporangia globose; stalks short or long; capillitium lax, colourless.

AN ALPINE FORM OF ANELLARIA SEPARATA.

By Somerville Hastings, M.S., F.R.C.S.

Each region on the earth's surface has its own particular flora, the characteristics of which appear to be determined to a large extent by the physical conditions present. Flowering plants growing at high altitudes, have generally the following characteristics:

(1) They are stunted and dwarfed. Trees are rarely found in Switzerland above 7000 feet. The alpine willow for instance, creeps over the rocks and is rarely more than a few inches high.

(2) Perennials are relatively more numerous at high altitudes than in the plains. Owing to the shortness of the alpine season, the plants tend to produce their flowers directly the snow melts; flowers of the Crocus and Snowbell are actually seen piercing the snow.

It is also interesting to note that,

(3) When a species which grows in the plains is found in the Alps also, its flowers tend to be both brighter in colour and larger in size at the high altitude. Professor G. Bonnier was able to produce these changes experimentally by transplanting lowland plants to high mountains.

During the first three weeks in June, 1922, the writer was collecting plants round Grindelwald, Switzerland. To the south, east, and west of this village are alps or mountain pastures where cows are taken to feed during the summer months. The season was late and no cattle had yet reached these pastures. Already, however, a good many fungi had appeared and it

1. *Anellaria separata.* × $\frac{1}{3}$

2. *Anellaria separata.* × $\frac{1}{2}$

seemed to the writer that similar characteristics to those described above for alpine flowering plants, had been acquired by some of these. Many specimens of *Anellaria separata* were found in the alps on all three sides of Grindelwald, between 6000 and 8000 feet, and in all not less than 200 were examined. In all cases the cow-dung on which they grew must have been deposited the previous summer, as no cows had yet reached the pastures.

It was observed that,

(1) All the specimens of *Anellaria separata* seen, had short stalks, and in no case were the stalks longer than twice the diameter of the cap.

(2) Owing to the lateness of the season, and the fact that the cow-dung cannot have been free from snow for more than a few weeks, it would appear almost certain that the mycelium must have passed through a resting stage during the winter months.

(3) The caps appeared definitely larger than those familiar to the writer in England. Unfortunately no measurements were taken.

The two photographs reproduced were taken at about 7400 feet on the slopes of the Lauberhorn, close to the little Scheidegg Pass, on June 22nd, 1922. There was unmelted snow quite near them, and they could not have been bare of snow for more than two or three weeks.

EDIBLE FUNGI.

By Carleton Rea, B.C.L., M.A., Hon. Member British Mycological Society, membre d'honneur de la Société mycologique de l'Est, etc.

It is unnecessary for a would-be mycophagist to determine his species as accurately as a systematist, but at the same time it is necessary that he should get approximately near the plant that he has in view or he may suffer himself for the erroneous determination. In this case however he has the comfort of knowing that he has only misled himself. I consider a student of our larger fungi is really making some progress when he feels competent to identify the species and to back his opinion further by eating it. This is a much better way to acquire a knowledge of their edible qualities than one I saw described in the obituary notice of our late member, the Rev. D. C. O.

Adams. His wife and son gathered some examples of a fungus and insisted on the father alone partaking of it at the evening meal: next morning after ascertaining from the prover that no ill-effect had resulted the son exclaimed, "Hurrah, mother, we have discovered another edible fungus." This story I fancy is older than Adams and like many others related about Mr Gladstone were previously applied to Talleyrand. In my recent work on the British Basidiomycetae I have enumerated all those that were known to be edible and in the majority of cases this was based on personal experience. I consider a fungus described as edible should also connote that it is palatable. Some years ago we had the good fortune to find a few examples of the rather rare *Hygrophorus russula*, and after we had duly studied the same we ventured on cooking it, as it is considered quite a dainty on the Continent. Guess our surprise to find when served at dinner it had a most disgusting bitter taste and we proceeded no further with it, although I revel in the taste of quinine and am not adverse to a gin or sherry and bitters as an appetiser. Either foreigners have a different palate to my own or the fungus has a different flavour in foreign climes. This may be true because we know of several cases in systematic mycology, especially amongst the Russulae, where such a variation is attributed to the habitat. I am not quite certain that all our tastes are alike and perhaps that is lucky, as otherwise, as Punch said, "they would all have wanted to marry my old woman." I know of no standard of taste and until the British Association have settled our colour standard referred to them by us many years ago I see no useful purpose in asking them to deal with this as a matter of pressing, national importance. Until a saporometre is invented I fear we shall have only to record our individual appreciation of the qualities each fungus possesses from a gastronomic point of view. Our common mushrooms in my opinion are coarse in flavour, and not to be compared with the delicate taste of *Amanitopsis vaginata*, a dish fit for the most fastidious epicure. In a review that I read lately the writer complained of the absence of any English names for our fungi and I admit that I cannot give you one for the Amanitopsis. But what do I mean when I use the word common mushrooms? I fear I have no special one in view, but generally the collective assortment exposed for sale in our shops and markets. When I address a learned body like yourselves I can assert that *Psaliota haemorrhoidaria* and *exserta* have a much finer flavour than either *Psaliota campestris* or *arvensis* and are easily recognised by the sanguineous coloured juice, but I should hesitate to popularise their name by the term used by Bernard Shaw in his "Pygmalion." With regard to

Amanitopsis vaginata, fulva and *strangulata* I have no compunction in indorsing the art critic's remarks concerning a classical figure of Tademas that "we should like to see some more of you," because its flavour is so refined and delicate. If anybody is dyspeptic, then I strongly advise them to avoid those mushrooms that turn yellow when bruised or handled. I am referring to *Psaliota xanthoderma* and *flavescens* more especially because owing to a personal idiosyncrasy some people are unable to digest these without grave inconvenience. Some authors would add to these *Psaliota arvensis*, the horse mushroom, or Abrahams, as they are called by the rustics in Worcestershire, but I think this is largely due to confusion with the other two species or to an excessive indulgence in the repast. From Psaliota we naturally pass on to Lepiota because these two genera have the same form being only differentiated from each other by the colour of their spores. This brings us to a consideration of the Parasol mushrooms, *Lepiota procera, L. prominens, L. rhacodes, L. puellaris, L. permixta, L. excoriata, L. gracilenta* and *L. mastoidea.* These are all easily known amongst the Lepiotae by their large or comparatively large size, their floccose flesh and the presence of a distinct cartilaginous collar at the apex of the stem separating it from the free gills. All of these are equally edible but I consider those in which the flesh reddens on exposure to the air of a better and more refined flavour than the others. *Lepiota procera* is characterized by the snake-like markings on the stem and its white flesh; these markings on the stem are due to the sudden elongation of the stem and the external stocking or cuticle is unequal to the strain and so becomes cracked transversely. *Lepiota rhacodes* has coarser scales or patches on the pileus, a smooth stem and red flesh. *Lepiota permixta,* as its trivial name denotes, resembles *L. procera* in the markings on the stem but has the reddish flesh of *L. rhacodes. Lepiota gracilenta* possesses smaller innate scales on the pileus, the markings on the stem arise from distinct yellowish scales and the flesh is white. *Lepiota prominens* resembles *L. procera* in the scales of the pileus and prominent umbo, but resembles *L. gracilenta* in the squamules on the stem and white flesh. *Lepiota puellaris* is entirely white and the smooth stem is mealy at the apex and the flesh is white or only slightly tinged with red. *Lepiota mastoidea* is whitish like *L. puellaris* but acutely umbonate and much thinner, the stem is obsoletely squamulose and the flesh white. *Lepiota excoriata* is easily differentiated from the preceding Lepiotae by the cuticle of the pileus breaking up into large patches or scales and appearing as if it had been drawn inwards from the fimbriate margin, and by the smooth stem and white flesh. I have

previously mentioned the floccose nature of the flesh, and it is this character which makes these species such delicious esculents. I personally advise that all edible fungi should be cooked in an earthen casserole having a lid, with a plentiful supply of butter, margarine or other fats, and the addition of some salt and pepper. To appreciate thoroughly the distinctive flavour of different species I advocate that each species should be cooked separately whilst the lid will retain the aroma in the food, and when served either from the casserole itself or very hot on toast will constitute the *βρῶμα θεῖον* of the ancients. The length of time necessary for the cooking of different species varies enormously, from ten to fifteen minutes for *Amanitopsis vaginata* to over five hours for *Marasmius oreades*, but a little experience will soon enable the cook to judge the approximate time that should be allowed for each species. In practice it is often quite impossible to restrict the trial to one species and then one should deal with nearly related forms, such as Lactarii, Russulae, Hydni, Boleti and Cantharelli. It is not to be presumed that I guarantee the harmlessness of the fluid in which the fungi have been cooked, because we all know that the water in which *Helvella crispa* has been cooked contains a dangerous poison; you might as well expect consumers of gas to indulge in its deleterious by-products. So beware of what you add to your soup.

The Italians prefer *Lepiota procera* to our common mushrooms; it is because the floccose flesh absorbs an abundant supply of olive oil, and then the addition of a small bit of garlic completes the dish. I think it is an error to say that mushrooms are excluded from the Italian markets, though we all know that the worst wish an Italian can express against his foe is "that he may die of a Pratiola," which I should interpret as meaning any Agaric.

Amongst the smaller Lepiotae I can recommend *Lepiota amianthina* and the less common *L. granulosa.*

Amanita strobiliformis and *A. solitaria* are excellent and delicious esculents, but it is only in a few favoured districts in the south of England that these are found in any quantity. Elsewhere we only meet with *Amanita rubescens* in any abundance and its flavour does not appeal to me to recommend it, as I consider it is too soft and mushy, or as we colloquially say in Worcestershire, too mawsey to be palatable. I really draw your attention to the Amanitae in order that you may know what to avoid in the future, as one of our members did in the case of a particular brand of Scotch whiskey. It is absolutely necessary that no collector of fungi for the table should include any one of these in his gathering. They contain deadly and

insidious poisons that only attack their victims some hours after ingestion, and then only very rarely can any cure be effected. The greater number of these poisonous Amanitae are known by the large volva at the base of the stem, which the American mycologists have so aptly termed the poison cup, and it is absolutely necessary for the beginner to gather all his specimens with this intact so that he can satisfy himself as to its presence or absence. In *Amanita muscaria* the volva is friable and does not form a distinct cup, but a very little experience will enable one to recognize this species, and even the dark umber forms can be easily distinguished by the yellow flesh just below the epidermis. The danger in advocating the use of *Amanitopsis vaginata* as an esculent is the fact that this also has a free volva at the base, but it consists of a free, lax, sheathing membrane, and there is no ring on the stem. One must be very careful not to mix it up with *Amanita pantherina*, in which the ring is often evanescent, but the volva is quite different and is not lax and sheathing. The pink-spored Volvariae, which in form resemble Amanitopsis, should equally be avoided. René Maire has recently proved that the African form of *Volvaria speciosa* is edible though this fact remains to be proved for it elsewhere.

Tricholomas give us many delicious esculents, and amongst these I can recommend *T. portentosum*, *T. gambosum*, *T. Georgii* and *T. nudum* as being a welcome addition to the evening meal, but *T. personatum* and *T. sordidum* I do not rate so highly. *Hypholoma appendiculatum*, though of fragile consistency, is an appetizing morsel and can often be collected in sufficient quantity to form a dish. The large Clitocybes, *C. nebularis*, *C. odora*, *C. viridis*, *C. geotropa*, together with *Cantharellus cibarius*, *Hydnum repandum* and *Pholiota aegerita* make very substantial and enjoyable meals and I think many of the modern text books do not attribute enough value to their nitrogenous qualities or calorific worth, being led away by the fact that a number of analyses show them to contain from eighty to ninety per cent. of water. They seem to forget that we do not eat them in this state any more than vegetables, but only after the same has been dissipated by cooking. My daughter informs me that the efficient cooking of these large fleshy species is greatly facilitated by cutting them up into strips or slices. The smaller Clitocybes, *C. infundibuliformis*, *C. dealbata*, *C. fragrans* and the polymorphous *Laccaria laccata* are tender and delicious esculents, and the last is available for many months in the late summer and autumn. *Collybia velutipes* generally does not grow in any abundance until the night frosts are somewhat severe and many times on Boxing Day I have gathered this tasty morsel.

I think it is safer to refrain from the pink spored species, but *Clitopilus prunulus* forms an exception, and is very good eating indeed. I have only tried the viscid Hygrophori a few times, but in the other sections I have enjoyed many an excellent dish of *Hygrophorus pratensis, H. virgineus, H. niveus, H. russo-coriaceus, H. puniceus, H. chlorophanus* and *H. psittacinus.* Many of these are rather small in size, but they decrease very little in the cooking, and can easily be collected in great numbers in the late autumn. I have tried *Gomphidius viscidus* on several occasions and enjoyed it, but some people find it rather hard of digestion, and I only take it home when nothing better is about. The Pleuroti often occur in such great abundance on a fallen trunk that it is an easy matter to secure a sufficiency. These include *Pleurotus corticatus, P. dryinus, P. ulmarius, P. sapidus,* and *P. ostreatus.* All of these are excellent esculents but I think *Pleurotus sapidus* has the best flavour. The Russulae constitute one of our best groups of fungi for the table. Their flesh is tender and delicate in flavour and they can be obtained often from early summer to the winter months. I include the following in my list of delicious esculents, *Russula lactea, R. incarnata, R. virescens, R. lepida, R. azurea, R. cyanoxantha, R. heterophylla, R. galochroa, R. integra, R. xerampelina, R. alutacea, R. vesca, R. punctata* and *R. lutea.* Some people seem to experience a difficulty in distinguishing the species of Russulae, but in many cases this is unnecessary for the mycophagist, as it would make no difference if he lumped the first five mentioned under one species or failed to differentiate *R. cyanoxantha* either from *R. vesca* or the mild tasting form of *R. atropurpurea* which is equally edible. In fact, I think that all the bright coloured species with mild tasting flesh when raw, may be safely indulged in with impunity. Two of the Lactarii are equally delicious, namely *Lactarius deliciosus* and *L. volemus,* but it is only rarely that we have the good luck to meet with the latter in sufficient quantity for the table. *Lactarius glyciosmus* and *L. subdulcis* are also very good eating, the former being the better of the two. Both *Coprinus comatus* and *C. atramentarius* are excellent esculents, and should be eaten the day they are gathered, as their autodigestive habit will allow of no delay. I remember once having had the former served to a party of sportsmen at a dinner and they imagined they had partaken of some unknown fish. The Americans also consume *Coprinus micaceus,* but up to the present I have not tried it, and so cannot say whether it is palatable or not.

I have already referred to the long time necessary to cook *Marasmius oreades* efficiently and although it is an excellent esculent I think it is much better to dry the same in an air current

and reserve it for winter use or as a flavouring to soups. *Lentinus cochleatus* is a toothsome morsel when it is thoroughly cooked and deserves a trial for its excellent flavour. For some years I refrained from trying *Craterellus cornucopioides* as its appearance did not appeal to me, but when once tasted all my prejudices vanished and I now rank it amongst one of the best. In my early days I was inclined to think that it only grew at the close of the fungus season but since then I have gathered several collections of it as early as July or August. Having passed in brief review the leading esculents included in the Agaricineae I will now say a few words about those included under the Boletineae. Personally I do not favour *Paxillus involutus* as an edible because I rank it in the same category with *Amanita rubescens* and consider it too soft to be palatable. It is very probable that I am wrong as to this and that both of these may be very highly esteemed by other people. *Paxillus giganteus* on the contrary is a great favourite and I only regret that I so seldom find a large ring of it in good condition. I fear I should only weary you if I were to extol the excellent qualities of the greater number of the Boleti because they are all so very good in their way, of splendid flavour and nice consistency. Before they are cooked I recommend that the tubes should be removed. This I generally do in the field when collecting and it is also advisable, especially with the very viscid kinds, to remove the pellicle of the pileus which is generally easily separable. After the tubes have been removed you will often find that there is comparatively little flesh left to the pileus and so I would urge every one to bring home all the sound stems as well, because if these are cut into thin transverse sections they will cook in the same time as the rest of the pileus, and in fact cannot be distinguished from it. In this way a few specimens of *Boletus edulis* will make quite a nice dish. I certainly consider the members of the edules group the greatest dainties and thereunder would include *Boletus edulis, B. pinicola, B. reticulatus, B. aestivalis, B. aereus,* and *B. impolitus.* Next in order I would rank *Boletus versipellis, B. scaber, B. badius* and *B. granulatus,* and in a lower category *B. luteus, B. elegans, B. bovinus, B. chrysenteron* and *B. subtomentosus. Gyroporus castaneus* is nearly as delicious as *Boletus edulis* but it is very seldom that one finds it in sufficient quantity for the pot. Amongst the Polyporaceae there are comparatively only a few that I can with any confidence recommend, but perhaps it is my own lack of experience in this section, because I have not emulated Mrs Hussey in partaking of *Polyporus squamosus,* which she says is like eating saddle-flaps. Under this head I would enumerate *Polyporus umbellatus, P. frondosus* and *P. intybaceus,* but I consider

the last is by far the best. The beef steak fungus, *Fistulina hepatica,* is well known to you all, but when cooked it has no appreciable flavour unless it has been gathered too young when it is too astringent for words from its tannin contents. I consider the best way to deal with it is to cut it up into pieces and place the same in vinegar, much in the same way as we do with beetroot. I have already mentioned that it is advisable to cut *Hydnum repandum* up into slices before cooking, and we often find that both this and *Cantharellus cibarius* are greatly improved by being soaked for a time in milk. I have only tasted one other Hydnum, namely *H. imbricatum,* which has a very fine flavour and is far superior as an esculent to the common *H. repandum.* It is fairly common in the north of Scotland but scarce I believe elsewhere. *Sparassis crispa* and *S. laminosa* are the only members of the Thelephoraceae that I have ever eaten; they are both excellent in flavour and a single specimen is enough for one meal. A great number of the Clavariae are edible but with the exception of the large branched species it is comparatively seldom that one is tempted to try their esculent qualities. The very brittle *Clavaria vermicularis* has a taste like cheese straws when cooked, but although I have many times tasted it when raw, I have failed to find this flavour. I have also enjoyed several cookings of *Clavaria pistillaris,* but on one occasion I found it very bitter and distasteful, and came to the conclusion that it must have been affected by some parasitic Hypomyces. With regard to the smaller Clavariae such as *C. cristata, C. cinerea, C. rugosa,* and *C. corniculata,* I only recommend their trial when they are in a fresh growing condition and not dried by wind or exposure to the sun, because in this state they are rather leathery and tough. *Clavaria amethystina, C. Krombholzii, C. Kunzei, C. botrytis, C. flava, C. aurea,* and *C. formosa* are all delicious and can often be found in abundance. With regard to *Clavaria formosa* Messieurs Heim et Malençon state that it produced violent diarrhœa and should be classed "non comme une espèce comestible, mais bien comme un agréable et très efficace purgatif." This does not accord with my experience as I have consumed it without any inconvenience. I have tried the Jew's Ear, *Auricularia auricula-Judae,* but it is rather tasteless, though undoubtedly highly nutritious. All the puff balls are excellent eating; they are very tender and delicate in flavour and taste very much like cooked brains. They should be gathered only when the flesh is quite white inside and cut into thin sections about a quarter of an inch thick. The exterior skins and sterile bases should be peeled and rejected before they are cooked. It is only *Lycoperdon giganteum, L. caelatum, L. saccatum,* and *L. excipuliforme* that are really large enough

to furnish a meal, but the smaller ones when so treated as above set out will make a welcome addition to other edible fungi. We know that all the species of Morchellae and Helvellae are very delicious esculents, but I think the flavour of these is greatly improved and their flesh made more tender if they are cooked in some good stock and then served on toast, because they are of a somewhat cartilaginous consistency. I have previously insisted on the necessity of rejecting the liquid in which *Helvella crispa* has been cooked and I think this should always be done with all the edible Discomycetae. These should never be eaten raw as grave inconvenience has been caused to persons partaking of them in this condition. In some years in the spring we meet with great numbers of *Disciotis venosa* and *Sarcosphaera coronaria*, and again later on specimens of *Aleuria vesiculosa*, *Otidea onotica*, *Otidea leporina* and *Peziza aurantia* are abundant. These are all highly pleasing to the taste and of a delicate consistency. I have now passed in brief review the principal esculent fungi that I have personally tested. They are all of excellent flavour and form a very valuable addition to our somewhat limited cuisine. In recent years many of us have been unable to afford many dainties and meatless days were often the rule, especially at hotels during the war. These appetizing morsels are open to us all and it only requires a little knowledge to identify the greater number of these. There is an old saying about mushroom eaters that those who eat them many times "nil amplius edit" (eats no more of anything), and I dare say many of our members feel inclined to wish that I had done the same before inflicting this long paper upon you. Lastly I may express the hope that some of our members who came to scoff will remain to prey.

NEW BRITISH DISCOMYCETES.

By W. D. Buckley.

The study of Discomycetes pursued as a recreation while on business journeys in many parts of the country has brought several interesting species under observation. The working out of the details from notes made at the time and specimens preserved has had to be deferred until opportunity could be found to consult the literature. The present notes and records relate to some of the most interesting species so far identified. A visit to Scotland for fourteen weeks convinced me that the mild and

humid sub-alpine districts of the west and north would well repay close investigation. The extensive forest fires which occurred in 1920 and 1921 left burnt ground on which many interesting Discomycetes were found. I have to thank my friend Mr J. Ramsbottom of the British Museum for his continued kind encouragement to give attention to the scientific side of the subject and to him I owe a debt of gratitude which I cannot sufficiently express for the benefit of his critical advice.

RAMSBOTTOMIA nov. gen.

Ascomata terrestria, plerumque laeticoloria, parva, lata primum orbicularia dein plana vel lenticularia, externe pilosa, pilis coloratis; asci ampli, maturitate prominentes, operculati, iodo non caerulescentes, octospori; sporidia globosa vel ovata, aspera vel echinulata, hyalina; paraphyses conspicui, iodo atrovirescentes, granulas coloratas continentes.

This genus is best placed immediately following *Boudierella* Sacc. in the Pseudo-Ascoboleae of Boudier's classification.

R. lamprosporoidea n. sp.

Ascomatibus dispersis vel gregariis, primum turbinatis dein planis regularibusque, in majoribus speciminibus explanatis lobatisque, externe pilis longibus, tubulosis, pallide brunneis dense vestitis, pilis ultra marginem non exstantibus, 160–285 × 11–18 μ, ramosis, septatis, interdum ad septa constrictis; hymenio sordide luteo; excipulo parenchymatico, e cellulis amplis, polygonatis vel cuneatis composito, ascis magnis cylindraceis, apicibus late rotundatis, ad basim gradatim attenuatis, 220–325 × 21–29 μ, octosporis, iodo non caerulescentibus; sporidiis uniseriatis, hyalinis, rotundatis vel interdum late ovatis, ad maturitatem guttula magna una ornatis, 18–20 μ diam., reticulatis, echinulatis, spinulis longitudine inter sese valde irregularibus 2–5 μ long.; paraphysibus cylindraceis, clavatis, sparse septatis, 340–350 × 2–3·5 μ, ad apicem 6 μ diam., granulis aurantiacis repletis, iodo atrovirescentibus.

Hab. ad terram argillaceam nudam vel inter muscos in collibus. Dunoon, Argyllshire. May 1921.

This well-marked species was found in some numbers in a small area at Dunoon. It much resembles *Lamprospora Crec'hqueraultii* (Cr.) Boud., but is abundantly distinct in the densely pilose exterior. The hairs are very long, tubular, thin-walled, and arranged in branching fascicles.

Lamprospora campylopodis n. sp.

Ascomatibus gregariis vel dispersis, unicoloribus, flavidis sessilibus, glabris, lenticularibus, minutis usque ad 1 mm. latis, ad maturitatem expansis, tenuissime et laceratim marginatis, cortice parenchymatico, e cellulis polygonatis mediocribus, ad

marginem longioribus composito; ascis cylindraceis, clavatis, ad apicem rotundatis ad basim attenuatis octosporis 180–215 × 18 μ, iodo non caerulescentibus; sporidiis globosis, valde et regulariter reticulatis, 15–18 μ diam.; paraphysibus filiformibus, ad apicem vix vel haud ampliatis, septatis, quam ascis multo longioribus, 230–240 × 2 μ, granulis aurantiacis repletis, iodo viridescentibus.

Hab. ad terram inter muscos (*Campylopus fragilis*) ad radices Pini truncorum in locis humidis. Dunoon, May 1921.

This extremely minute species is closely allied to *L. miniata* (Cr.) de Not. and *L. areolata* Seav. It differs from the former in its constantly minute size and more regular finer network on the spores and from the latter in the absence of the peripheral flange on the spore and in the paraphyses greatly exceeding the asci and not being thickened above: it differs, moreover, from both species in colour.

Ciliaria caudata n. sp.

Ascomatibus congestis, sessilibus, primum orbicularibus, clausis dein poro patescentibus, demum in discum planum explanatis, crassis, ad 4 mm. diam., brunneis, externe pilis brunneolis, pachydermaticis, acutis, ad basim attenuatis et plerumque bifurcatis sparse vestitis, densioribus brevioribusque juxta marginem, ultra quod vix excedent, usque ad 185 × 14–18 μ; hymenio rubro excipulo corticeque parenchymatico, cellulis amplis, brunneolis; ascis cylindraceis ad apicem rotundatis, pedicellis bifurcatis, paulum angustatis, octosporis, 290–320 × 21 μ; sporidiis ellipticis, hyalinis, 25–29 × 16–18 μ, primum biguttulatis utrinque obtusis, intra folliculum grosse reticulatis, appendiculatis, cauda tenuissima, recta vel curvata, ad 18 μ longa; paraphysibus cylindraceis, clavatis, saepe ad apicem furcatis, septatis, usque ad 270 × 3·5–4 μ, granulis aurantiacis repletis, iodo colore vineo vel viride tinctis.

Hab. ad terram inter muscos in locis humidis collinis. Dunoon, May and June 1921.

This species which macroscopically resembles *C. umbrorum* (Fr.) Boud., is well marked by the extremely coarse and large reta on the spores which are enclosed each in a separate follicle and by the presence in the fresh condition of a long fine cilium such as occurs in the spores of *Peziza aurantia* Pers. Hennings in Warburg's Monsunia, I, 1879, p. 35 has described two species of Lachnea from Java, *L. appendiculata* and *L. Fleischeriana*, and von Höhnel in Sitzungsber. k. Akad. Wiss. Math.-Nat. Kl. CXVIII, Abt. I (1909), p. 396, a third species, *L. folliculata*, also from Java, which exhibit similar spore characters—gross reticulations, with a follicle and appendages. von Höhnel remarks:

"Indessen ist höchst auffallend, dass bisher anderswo *Lachnea*-Arten mit derartig gebauten Sporen nicht gefunden wurden. Ich halte es daher nicht für unmöglich dass diese drei Arten in den Formenkreis einer gehören."

Neotiella Hetieri Boud. in Bull. Soc. Mycol. Fr. XII, p. 12 (1896), pl. III, f. 2.

Apothecia gregarious, opening by a pore, hemispherical, then plane, bright yellow, 1–2 mm. broad, externally densely clothed with long, slender, flexuous white hairs, rarely septate; furnished towards the margin with numerous white, pointed, rigid 2–4 septate white hairs 140–180 μ long × 5–9 μ broad, usually arising in pairs from a common cell; excipulum parenchymatous, cells polygonal, small about 7–10 μ in diam., becoming longer and clavate at the margin. Asci cylindrical, apex rounded, base gradually tapering 215–230 μ long × 11–16 μ broad, 8-spored, spores obliquely uniseriate 16 μ long × 9–11 μ broad, smooth, hyaline, broadly elliptical containing one large central gutta. Paraphyses filiform becoming clavate and frequently 2–4 times branched towards the apex, containing orange granulations, septate, up to 235 μ long × 2–3 μ broad (7–9 μ at the apex).

Amongst moss on burnt ground in Pine woods. Inverness, N.B., March 1921; Oxshott, Surrey, Oct. 1922, and Farnham, Bucks., Febr. 1923.

This species is at once recognised by the two kinds of hairs, those on the excipulum being long and flexuous and usually non-septate whilst the marginal ones are pointed and rigid. The colour of the hymenium in my specimens was uniformly yellow and not orange-red as figured by Boudier. The asci, moreover, are constantly somewhat longer than in the original description, where they are recorded as 200–210 μ in length. A character not mentioned by Boudier is the branching of the paraphyses. Boudier placed the species near to *N. albo-cincta* (B. and Br.) and *N. albicans* (Fuckel). It would appear to resemble *N. nivea* (Romell) even more closely.

Lamprospora dictydiola Boud., Hist. et Class. d. Discomycetes d'Europe, p. 68 (1907); Icon. Mycol., pl. 403.

Apothecia scattered, 3–5 mm. broad, orange red, marginal flange paler and dentate. Asci cylindrical, hyaline, apex rounded, base long and tapering, 230–300 μ long, 13–15 μ broad, 8-spored, spores uniseriate, round, hyaline, very finely reticulate, containing one large gutta, 16 μ in diam. Paraphyses filiform, apex slightly thickened, up to 6–7 μ broad, filled with reddish contents, septate and forked at the base.

On burnt ground amongst Moss. Farnham, Bucks., Febr. 1922; near Mere, Wilts., May 1923.

This species is distinguished from its allies by the extreme fineness of the reticulations on the spores. A comparatively large species it is easily seen on account of its brilliant colour. Seaver records (Mycologia, VI, p. 9 (1914)) that in two small gatherings of this fungus in America the apothecia were only about 1 mm. across.

Saccobolus globulifer Boud. in Ann. Sci. Nat., 5th ser., X, p. 232 (1869), pl. 9, fig. XXI.

A number of specimens of this Discomycete came up on what appeared to be horse dung taken from a manure heap at Leeds in April 1922. Macroscopically it is indistinguishable from *S. violascens* Boud. with which it was growing. Characterized by the balling of the spores which when separated are seen to be wedge-shaped, rough on the outside and smooth on the two inner sides of the wedge, it is easily recognised under the microscope. The specimens examined agree closely with Rehm's description and illustration in Rabenhorst's Kryptogamen-Flora, III (1894), pp. 1111 and 1119.

Apothecia scattered or gregarious, sessile, cinereous violet 0·5 mm. broad. Asci clavate, apex blunt, base prolonged into a stem, 70–90 μ long × 20–30 μ broad, 8-spored. Spores wedge-shaped, smooth on the two inner sides, rough on the outside, at first hyaline, passing through violet to brown when mature, 14–16 μ long × 7–8 μ broad, at first combined in a ball and afterwards separating; the secondary membrane typical of the Saccobolaceae not seen. Paraphyses filiform, septate, clavate upwards, 3 μ broad (× 5–7 at the apex), colourless.

As pointed out by Rehm, his description does not wholly agree with the figures in Boudier's classical monograph on the Ascobolaceae.

REMARKS ON THE NATURE AND DEFINITION OF SPECIES.

By R. C. McLean.

The radical difficulty besetting all classification, the delimitation of the units employed, is nowhere more prominent or more acutely felt than in mycology, where the study of the subject organisms has arrived at a higher degree of intensity than prevails in possibly any other plant group. This very intensity of study has led to the expression of opinions antagonistic to those prevailing among the majority of systematists in other

groups, regarding the worth of the traditional concept of specific entity, a result which is bound to cause the reflective mind to ponder on the possible consequences to systematic Botany as a whole of the extension of the methods of study by cultural and hereditary observation which have led to the pronouncement of these protestant doctrines among mycologists. Not that similar signs are altogether wanting elsewhere. The geneticist has long been at war with the systematist among the Angiosperms and yet the systematist, though much battered, stoutly maintains the essentials of his position. It is worth while enquiring how this comes to be. The answer will not be without general interest.

The arguments against the current method of systematic mycology and particularly against its morphological bias have been urged within the last few years by Brierley*. Fortunately it need not concern us, from the present point of view, to dispute the theoretical soundness of the position taken up by those of this school, but it is vitally necessary to consider the relevance of their contentions to the work of the descriptive systematist.

Cut down to the bone the charge against current systematic is simply that its "species" are not homogeneous units, and further, that morphological comparison alone is incapable of delimiting such units. For such a charge to have any revolutionary effect it is plainly necessary for those who uphold it to demonstrate that there exist, *per contra*, certain homogeneous units, demonstrable experimentally by some means, to which the unit term species should be transferred. If this can be satisfactorily done, then, it is contended, the morphologically established groups would have to be re-christened with a substitute appellation and their heterogeneous nature confessed. It is surely, however, pertinent to enquire whether any systematist at the present day, when giving a new name, does seriously imagine that in his new "species" he has defined an immutable and inflexible unit, and, whether ingeniously elaborated argument to the contrary is not to a large extent knocking at an already open door? The problem, so far as the systematist is concerned, remains open; it is his critics who have taken up an exclusive position demanding rigid justification.

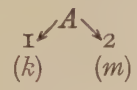
Continued analysis of the species concept has led these critics to the formulation of an ideal unit, which shall be, like a metre measure, intrinsically invariable wherever found, although (to carry on the analogy) its material manifestation (as of wood, steel and so forth) may vary circumstantially; and this is averred to be the biological unit without which any systematic biology is hopeless. This ideal unit is depicted as consisting of a per-

* Brierley, W. B., Some concepts in mycology—an attempt at synthesis. Trans. Brit. Mycol. Soc. VI, p. 204 (1918).

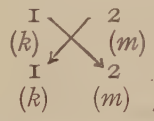
sistent specific framework, liable, it is true, to phenotypic distortion or to mutational collapse, but itself incapable of any permanent alteration from without.

Now it cannot be too strongly insisted that such an ideal is wholly chimerical. All experience, now confirmed and substantiated by physico-mathematical demonstration, leads to the conclusion that there are no units in nature which possess an absolute value, without relation to the circumstances in which they occur and that to search for them is a waste of time. It is only another phase of the secular Quest of the Absolute, as illusory as the Philosopher's Stone. To accept such an ideal is to abstract the species from its environment and endow it with a transcendental entity of its own, in the guise of a pure force-system divorced from all relation to the material substrate. Moreover this system, admittedly involving an almost infinite complexity of interactions, is figured as permanent, but in a wholly transcendental mode, as a mediate factor threading through a complex series of immediate changes in the growth form, never directly demonstrable but always present as an abstract bond, linking together all the phases of the change-series.

It may be objected that permanency of constitution is demonstrable by permanence of reaction under standardised conditions. Supposing then a certain organism A to be grown under two distinct sets of conditions 1 and 2, in which it develops with two distinguishable facies k and m.



If transplanted, reversal occurs;



and it may be argued that in this way the constitution of the organism is shown to be unchanged throughout. This however is a pure assumption under the circumstances. All that our observation shows us is that the strain is capable of certain changes, that in one set of circumstances these changes may be reversed and that in another set of circumstances they may be perpetuated. What the nature of these changes may be and whether they leave unaffected any permanent specific framework underlying them is not brought into the evidence at all. We cannot go beyond the observed fact that the organism is

plastic and interacts with a given environment to produce a given result; but whether any part of the interacting force-system "Organism" remains unmodified by its successive contacts with a series of other force-systems "Environment 1," "Environment 2," and so forth, is unproven and perhaps unprovable. It is moreover antecedently improbable. The only factor possessing any demonstrable rigidity is the standardised environment and it is much more economical of hypothesis to suppose that constancy of reaction is assured by the conformation of the plastic living constitution to it. The possibility of such conformation will naturally govern the viability of the organism in that environment and the act of conformation moulds it into the appropriate form, but neither form nor conformation have any individuality apart from the environment which elicits them from the organism; while the latter, primordially amorphous, responds in a series of symmetrical fashions to every external impress *within the limits of its inherent plasticity*. Each fashion of response represents one of the despised "evanescent morphological facies," which however exist and which alone have been demonstrated to exist.

The unproven assumption of a permanent physiological constitution (implying of course genetic constitution) underlying all phenotypic changes, permeates and vitiates the whole concept of the ideally pure species. The generations of a pure line are supposedly linked together by some character or characters which do not change and are therefore the true "specific indices," but it is logically impossible to prove that any such characters are altogether inaccessible to external influences. Experimental evidence, be it never so searching, is necessarily inconclusive, since whatever character we select for test the negative cannot be proved. Yet even within the limits of available experimental evidence there is material enough to support the positive, that every unit character, or, to confine ourselves strictly to demonstrabilities, the degree of expression of every unit character, is thus amenable to environmental control. Whether there is any absolute constant behind this "degree of expression" is exactly what has been called into question as unproven. The morphological facies is indeed the outward and visible sign of the metabolic rhythm, but is not this in its turn largely the reflection of its circumstances and neither the form of the one nor the other wholly self-existent? That the protoplasm does indeed maintain throughout all the situations in which it may find itself, some elements of continuity, relatively stable over moderate periods of time, is obvious; but these elements are, in general, much more fundamental than the unit distinctions of species, involving the degree of complexity of the plasma

relatively to that of other organisms. That is to say they involve constructional limitations such that the range of factors, material or dynamic, to which any given organism is capable of responding is intrinsically limited. No possible method of culture can change a bacillus directly into a *Botrytis*, but even in regard to the broad features which separate group from group, the fundamentals of structure or *hypomorphs*, as we may call them, in distinction from allelomorphs—these factors of constitution which rough-hew the generic and familial outlines of the organism—it still remains to assess the full effect of environmental pressure acting over long periods of time.

That which is passed from generation to generation is not *form* but *habit*, the fixity of which is in direct proportion to its previous duration; and on the extent to which this is compatible with a new environment will depend the continued survival of the organism. Habit being inevitably of finite duration can never attain to an infinite degree of fixity.

Inseparable from the enquiry into the possibility of physiological change is that into educability, a postulate which has been far too lightly accepted. It must be admitted at this present time, that much of the collected evidence supposed to uphold the idea is explicable on the ground of selection in mixed populations and that experience with pure lines under strictly standardized conditions renders it dubious. I have already pointed out that the mass of evidence illustrating that a given organism generally reacts to the same environment in the same morphological manner offers no evidence on the crucial point of the maintenance, throughout its history, of an identical constitution, but only suffices to show that its reaction in face of so and so is such and such, nothing more. Even the invariability of the organism in this restricted sense is, however, by no means certain and when we are offered growth on potato or onion as examples of the rigidly standardized conditions under which organismal reactions have been observed by its upholders, we may be permitted, perhaps, to doubt whether the alleged constancy rests on quite so sound a basis as we are expected to believe.

The converse problem, that of the nature of the alterations induced by environmental change is likewise often prejudiced by the presence of the same assumption of the self-existence of the specific form. Brierley's clear analysis has done much to resolve the issues and has emphasized the fallacious nature of much of the evidence adduced, particularly among the bacteria; where my own results in attempting to educate a pure line of a spore bearing anaerobe into toleration of flavine entirely bear out his negative experiences with *Botrytis cinerea*. The belief

that an organism can be so remodelled by its contact with a certain set of external factors that it refuses to return to its original fashion when returned to its original environment is unsupported by any conclusive evidence. It is, in any case, not to be apprehended *a priori* that an organism which has once clearly shown itself to be plastic by responding to a change of conditions, should suddenly become aplastically fixed in a new posture. Until such an eventuality be unequivocally demonstrated to occur we may safely leave it out of account in our specific determinations.

This negation is not to be regarded as excluding the possibility of spontaneous mutation; a kind of collapse—as we have already described it—of the specific framework; but nevertheless the same caveat as before must be entered against this proposition also. The manifold sequelae of heterozygosis must not be overlooked; which implies a more thorough scrutiny of possibilities than has been carried out in the cases of most observed "mutations."

On the environmental hypothesis of specific form which is here suggested, a pure mutation, should such a thing be shown to occur, would be held to alter the capacity of the protoplasm for response to the environmental factors, either in the direction of diminishing or in extending its sensitiveness to include new influences which previously did not perceptibly affect it. Within the limits of such an extension of the range of factors, whether climatic, edaphic or biotic, with which the organism is in sensitive contact, evolution, judged thermodynamically, will have advanced a material step through the mutation.

There is, however, another aspect of educability, often neglected, which suggests considerable possibilities when taken side by side with the hypothesis of pure mutation. Although it may not prove possible to alter experimentally the intrinsic capacity of a pure line with respect to some new factor, yet it is certainly possible to "acclimatise" even a pure strain to new conditions by the well-known procedure of moving by slow degrees. Instances of such occurrences are easy to procure at first hand in the laboratory and are on record from almost all groups of plants. Nothing, we may assume, has been permanently added to the constitution of the species by acclimatization. We have only suceeded in straining its powers of response to their utmost limit by avoiding destructive shock. There is nothing specially vital in such a process, for mechanics is full of similar effects. Thus, a wire will support a certain weight added to it in small increments, while the same weight suddenly applied breaks the wire. Again, a horizontal, suspended bar is acted upon by a longitudinal pressure, slowly applied: the bar

is moved as a whole without generation of heat. Apply the same force at a blow and the energy is resolved into molecular vibrations, maybe even disruptively, with much internal heat and no motion as a whole.

In extreme cases acclimatization may affect even the visible structure, particularly in organisms with many delicately correlated parts. Changes of this sort have been very generally ignored in the post-Darwinian discussion of evolution, because it is said, rightly enough in all probability, that none of them are permanent. By this is intended that if the organism or its offspring be removed to the old habitat the old form will reappear. Naturally; what else is to be expected in a plastic organism? But surely the fact merits serious consideration that *so long as the plant endures the new conditions* so long will its new facies remain constant; while in its offspring, each generation, if it does not suffer any mutation, may respond in the same fashion—so long as it remains under the same conditions. If then, the organism were to die out in its original habitat (as is happening for example to *Cupressus macrocarpa*, which has been carried to endless new habitats in cultivation) what would be left to distinguish our "ecad" from a species? All that we should know about it is what we know about any species, that in its normal habitat it had one form, observably constant under constant conditions, and that when moved it showed a liability to display other, apparently latent capabilities of development.

True, to go back to the beginning again, during the first few generations under the new conditions the new character might be, to an observer, obviously superposed during development on an originally different habit, manifested in the juveniles. But the living organism is not restricted to the passivity of our strained metallic wire. A fruit stalk thickens as the weight upon it grows heavy, a wire cannot. The plant has a plastic organization, governed by that mysterious process called "facilitation by repetition," mysterious in its cause but plainly manifest in its effects; through the operation of which we find the new characters of our ecad appearing earlier and earlier in each successive generation until they may even eventually show themselves in the embryo. The change-over is complete, our "ecad" has become a "species."

This fascinating idea, closely bound up with the phenomenon of embryonic recapitulation, is too big a matter to enter into here in the detail which its importance to the theory of plant evolution deserves; but this simple sketch of the principles involved will help to emphasize the view here taken, that *the organism is a crystallized habit.* Permanence, as applied to

organismal characters is a purely relative term and the apparent stability of some characters, generic and familial characters for instance, is accounted for, in the first place, by their more fundamental nature and the consequently greater length of time during which the organism has been in the habit of producing them, and secondly, by the restricted experimental possibilities, chiefly from the point of view of the required time, which limit us in attacking these primordial habits. Given sufficient time to produce acclimatization to fundamentally different conditions it would be difficult to set a theoretical limit to the extent to which we could mould the habit of our species.

It helps us likewise to emphasize the fallacy of the hunt for a wholly objective definition of the term species; a wild-goose chase after that illusion the pure species, which, apparently alone in the universe, maintains an aristocratic reserve of constitution, chemical or otherwise, relative to no basis but itself.

Chemical analogies, indeed, of the reaction of organism and environment are somewhat dangerous. Even if it be true that each species has a particular chemical composition, a specific protein, it is impossible to imagine that this modern version of the idioplasm undergoes no tautomeric changes in relation to its environment. The very elements are no longer the immutable constants that they once seemed. If such analogies really illustrate anything it is that both parties to the reaction, *i.e.* both protoplasm and environment, in our terminology, enter in greater or less degree into the actual constitution of the final product—the visible organism.

Nor is there any particular stage in its life-history at which a species may be considered as having withdrawn its constitution entirely from contact with the environment. There is no gonidium so dormant that it is wholly unresponsive to such fundamental factors as light and temperature: some indeed are quite remarkably sensitive. Moreover it is needless to labour the fact that the form of the mature individual is never wholly predetermined by the constitution of the antecedent gonidium.

Over against all such considerations we have to recognize the very high degree of constancy exhibited by many species in nature, a constancy to which the systematist is justified in pointing as a vindication of his general morphological usage in dealing with species.

There is no necessary contradiction between this observed fact and the foregoing ideas about the specific form as an environmental reflex. Many species are accurate environmental indicators; the given organism is never found apart from the given conditions, so that the recognition and description of the species are immediately possible without recourse to physio-

logical analysis. Into this class fall, no doubt, many fungi, since their secondary, dependent modes of nutrition render them less capable of existence under a wide range of conditions than the autotrophic plant. On the other hand there are many plants even among the fungi, which seem to preserve their identity closely over a wide selection of habitats. There is no real difficulty involved; these forms may indeed actually be in the first category though responsive only to a limited range of factors, common to all their habitats. No organism is sensitive to every one of the almost infinite number of the complexities of a natural habitat and many are extremely restricted, depending only on the co-existence of a small number of widely distributed influences and unaffected by a considerable latitude in those to which they are not sensitive. The result from the point of view of practical systematics is the same as before. These types can be recognized as morphological entities with a definite, though limited, physiological background. Whether they are made up of a mixture of convergent races is another question, which will only yield to physiological, or let us rather call it, ecological analysis; but we have already contested the assumption that such races are themselves a whit less dependent upon environment for their apparent constancy than is the aggregate form.

To the conception of the organism as a physiological equilibration functioning about a constant point we must oppose the modified conception of the organism in which nothing is absolutely constant, but in which those morphological features which have a relatively high quality of constancy derived from extremely ancient habit, form the basis upon which the specific character is superposed by the environment.

Such a resurgence of Lamarckianism into evolutionary thought will not surprise those who are acquainted with the work of Perrier and Gravier on Tachygenesis* and the exposition on "Mutations and Evolution" by Gates†; but those who wish to see how the importance of somatogenic characters has impressed itself on a mutationist should turn to the latter series of papers‡.

Brierley, in the paper already mentioned, draws a contrast between the dynamic and static ideas of the species, into which it would be idle to enter critically without essaying an analysis of the meaning to be assigned to the term "existence." Suffice it to say that if we accept the concept of organic form outlined

* Perrier, E. and Gravier, C. L., La Tachygénèse. Ann. Sci. Nat. Zool. XVI, p. 133 (1902).

† Gates, R. R., Mutations and Evolution. New Phytologist, XIX, p. 26 (1920).

‡ Now reprinted in book form.

above we perceive the species to be both event and thing, an event giving rise to a thing, a dynamic process resulting in a static equilibrium which is inherently stable. As the event, the intimate process by which environment acts upon protoplasm and hence upon gross form, is at present beyond our reach, we must be content to accept the result, the thing, as a sort of algebraical symbol for the unanalysed process which precedes it and is its proximate cause.

From these considerations we find ourselves led back to the morphological basis of specific distinction and it may be useful to reflect now, that the species is historically a morphological idea and to protest against the unjustified transference of an understood and accepted epithet to a hypothetical and possibly non-existent unit. Whether the group of individuals be big or little, diagnosed by a syndrome of characters or by a single one, the term *species* is rightly applied to it if it remains visibly constant under constant conditions. But, when we go beyond this to seek for imagined immutabilities abstractable from such a group by experimental analysis we pass to a region of new concepts demanding the employment of new terminology. Where morphological data are of the simplest order it is only natural that physiological criteria should predominate in the discrimination of groups; but no bacteriologist would pretend that types thus delimited are fixed entities any more than the others. On the other hand where morphological data are abundant they will naturally influence the student most. To draw a hard and fast line between the two procedures or to attempt to oppose them to each other in distinct categories, as has been done, is logically impossible. The student of higher groups knows, as a general rule, little directly about their physiological make-up. He has had to be content to rely upon their morphology as an eidolon of the inner mysteries; but where systematic biochemistry has come to his aid it is gratifying to observe how little it has found it necessary to amend the existing order; a striking vindication of an implicit assumption, venerable from age but none the less an assumption, that form is an index of constitution, which has not perhaps been allowed its full significance.

The species is properly a four-dimensional concept whatever the characters by which it is marked off. The time factor enters into it either in consideration of its stability, on the one hand, or as affecting, on the other hand, the sequence of events, determined by the impressionability of the organism in face of varying environments, which provide the material the dynamic phyleticist works with. Even were the organism a veritable Proteus, every phase which achieves a static existence becomes

in its turn the subject matter of the systematist and needs its label. It is of little moment to him that *Leontopodium alpinum* changes in a changed habitat; that does not affect the primary fact that *Leontopodium alpinum* exists and continues to exist so long as the appropriate environment offers itself.

To the present day systematist species are no more than a series of packets into which he sorts objects. About x, the intimate constitution of these objects, he makes neither assumptions nor prophecies; but, if $x \times y$ (the environment) $= xy$ (the observed object), he needs only to define the two latter terms as clearly as possible, and, if he can develop quantitative methods of assessment with which to do it, so much the better. Do not let it be thought however that it is any more scientific or that it assists in the delimitation of the species, to describe the various ecads formed by the organism in an arbitrary selection of different environments out of the innumerable possibilities, rather than to confine oneself to the most rigid possible definition of the exact natural habitat or habitats in which the form in question *spontaneously* occurs. These ecads may be the beginnings of independent species, as we have seen, and there must be infinite gradations of rank between one extreme and the other.

Classification is confessedly a subjective matter; but our intellectual limitations require it in order that we may view this universe through some sort of *grille* of co-ordinate axes, which will enable us to relate its multifarious outlines as harmoniously as possible to those elementary ideas with which alone we are capable of dealing. That there never is, nor can be, a perfect correspondence, need not put us greatly about so long as our end is served; for, in the ordinary acceptation of that term, Natural System is there none.

The expressions made use of by Farlow* are as true to-day as they were a quarter of a century ago and they convey the same opinions as those here maintained, so forcibly that some of his phrases may be effectively quoted in the present connection:

"Our so-called species are merely snap-shots at the procession of nature as it passes along before us. The picture may be clear or obscure, natural or distorted, according to our skill and care, but in any case it represents a temporary phase, and in a short time will no longer be a faithful picture of what really lies before us, for we must not forget that the procession is moving constantly onward and at a more rapid rate than some suspect."

"We should not allow ourselves to be deluded by the hope

* Farlow, W. G., The conception of species as affected by recent investigations on fungi. Bot. Sect. Amer. Ass. Adv. Sci. (1898).

of finding absolute standards, but it should be our object to arrange what is really known, so that it may be easily grasped and utilized."

"Utility may perhaps sound strange,...but in the end utility will carry the day in this case, for systematic botany is a means not an end."

It is a truism of philosophy that only that knowledge imports to man that relates to man. To pure intellect all facts are of equal value, interest and potentiality; but our gradations of value are individual, subjective and depend upon our human interest.

The formation of a classificatory system or the discovery of the Natural System, did it exist, is of no moment to a single human being apart from its human use. It is a tool simply, to be applied to certain material for the furtherance of our interests as living beings, with needs to be served in the examination of other living beings. By their suitability for their given purpose must all our tools be judged.

The final analysis of the systematist's groups into their constituent elements, profoundly important as its implications are from the physiological standpoint, takes place outside the limits innate in systematic thus subjectively conceived, and need not subvert its traditional method.

ECOLOGY AND PHENOLOGY OF SURREY MYCETOZOA.

By the Rev. P. J. Alexander, C.J.

The following notes on the Mycetozoa of Surrey are the result of ten years' systematic study, combined with assiduous hunting and careful annotation of the habitat of the species, the date of their appearance and the previous weather conditions. All information as to previous records, etc. that I was unable to obtain first hand has been kindly supplied by Miss G. Lister, F.L.S.

The ground covered is practically the whole county, with special attention to the central portion, within a ten mile radius of Weybridge. I am of opinion that one obtains better results, by a more concentrated attention to a restricted area, than by going further afield. Having a limited amount of leisure, I found myself compelled, by circumstances, to hunt for the greater

part of the year in a confined space, namely, the wonderful grounds of St George's College, Weybridge, known locally as Woburn Park. Here, in an area of just under a hundred acres, no less than 90 different species and 18 varieties have been recorded*.

There have been many notable forerunners in the same field. I have no knowledge of the extent of the work of Messrs Massee and Phillips, but no doubt many of their specimens were obtained in this county. The late Mr Arthur Lister, his daughter Miss G. Lister—the chief authority on the subject to-day—her sister Mrs Phear, and the latter's sister-in-law Miss Margaret Phear, have also made many notable finds especially in the south-west of the county; Mr E. S. Salmon has furnished useful records of the Reigate neighbourhood, and Miss A. Hibbert-Ware and Prof. Farmer have also been successful hunters in Surrey: so that we now have the record number of 128 species and 19 varieties, or two-thirds of the known British species.

The present list is of particular interest as it includes one species new to Europe: *Didymium anomalum*; one new to Britain: *Trichia alpina*; two new to England: *Physarum globuliferum* and *Ph. crateriforme*; Miss Lister's recently published species: *Didymium trachysporum*; and nearly thirty new to Surrey.

I gladly take this opportunity of expressing my grateful thanks to Miss G. Lister, F.L.S., for all her help in examining my finds and checking my results, and for the valuable information and directions contained in her various writings which have been my guide throughout.

My experience has taught me that much precious time may be lost by looking for specimens at times of the year when they are not likely to be found, or in situations where they have never yet been met with. It thus occurred to me that records of dates and habitats would be a useful—though not infallible—guide to others who find their pleasure in like pursuits†.

1. *Ceratiomyxa fruticulosa* Macbr. is very frequent from May to October on rotting lime, alder, birch and pine wood and appeared oozing out of the ground in great masses of slime in October, on a pathway thick with old pine sawdust at Weybridge.

2. *Badhamia capsulifera* Berk. appears in late autumn every year and has been found in November on fir, oak, alder and lime branches; in the last case the plasmodium was feeding on *Exidia glandulosa*.

* Any mycologist wishing to hunt over the same ground will always be very welcome.

† Those species marked with an asterisk were first recorded for Surrey by the writer, those marked † were first found by Miss G. Lister, F.L.S.

*3. *B. utricularis* Berk. A very common species. In March it was noticed on rotting willow slips, and from April to November in its classic haunt on leathery fungi. The plasmodium has also been observed among poplar logs feeding on *Pleurotus ostreatus*.

4. *B. nitens* Berk. A fine healthy growth of this species was found in May 1920 on a fallen oak branch, in the grounds of the Royal Horticultural Society's Gardens at Wisley. At first glance it could hardly be distinguished from the golden yellow lichen on which it was growing.

*5. *B. macrocarpa* Rost. may be met with every year in late autumn. A sturdy stalked form, very like a robust *Physarum pusillum*, appeared in November 1922 after a month of remarkably low rainfall, on the bark of white poplar logs in the grounds of St George's College, Weybridge.

†6. *B. panicea* Rost. occurs frequently throughout the year. It has been recorded in January, March, April, July, August and plentifully in autumn. It would seem to have a preference for poplar logs but often creeps over adjacent leaves, etc. and has also been found on elder and tulip tree (*Liriodendron*).

†7. *B. foliicola* Lister was first gathered on a lawn near Witley in July 1908. It is not, however, uncommon and has since been found in February and March on beech leaves, on an oak trunk in June, on laurel and poplar sticks in a heap of faggots in October and on poplar and sweet chestnut leaves in November.

*8. *Physarum globuliferum* Pers. Although already recorded for Scotland by the Rev. W. Cran it was not obtained in England until September 1922 when a large growth was found in St George's Hills, Weybridge, on the bark of an old pine stump kept moist by overhanging bracken. This clustered form is bigger and has shorter stalks than the elegant American and tropical species.

†9. *P. viride* Pers. Has been found fresh in March on a laurel branch and also on alder and pine in September and October. A growth with sporangia varying from bright yellow to red (var. *aurantiaca*) was collected by Miss Lister in Richmond Park in August 1892.

10. *P. galbeum* Wing. This charming species is by no means of frequent occurrence. It was first recorded for the county at Witley on dead twigs in September. It has also been obtained in July, after twelve days of incessant rain, and again in December. On each of these occasions dead bramble stems provided the habitat.

11. *P. nutans* Pers. Abundant throughout the year but is most puzzling in some of its protean forms.

var. *leucophaeum* is almost as common between January and July.

var. *robustum* is frequent and has been found on laurel in May and on elm in November and throughout the winter and spring. It is nearly always on rotting wood.

*12. *P. crateriforme* Petch. After an exceptionally wet period this species was found for the first time in England, growing among lichens and associated with *Cribraria aurantiaca*, on an old pine stump on St George's Hills, in September 1921. The sporangia were so minute, and blended so well with the white tops of lichen, that they could not be distinguished with the naked eye, and it was only the appearance of some strange looking spores among those of the *Cribraria* that provoked a further examination of its well-concealed lurking place.

†13. *P. pusillum* Lister. A minute slender form of this species is frequently met with in heaps of old straw. In August and September a sturdy, robust form appeared in great profusion, on old pieces of white poplar bark, and in October it was again met with on the leaves of *Agave americana*.

*14. *P. compressum* Alb. and Schw. can be found at almost any time of the year. In February it occurred on the straw thatch of a haystack, in July a less robust form was running wild over dead ivy leaves, in September a stout growth appeared on willow bark and lime logs. A black stalk instead of a white one is sometimes met with, while sessile sporangia of a light brown colour are not unfrequent, and limeless sporangia have been noticed in December.

*15. *P. straminipes* Lister. has only once been encountered, although it is probably not uncommon in heaps of rotting straw. One good gathering of this species was made during a very wet July at Horsley, on the edge of a straw heap just where it mingled with the surrounding grass. It is like *P. didermoides* in the field, but its identity is instantly revealed under the microscope by the unmistakable patches of warts on the spore.

*16. *P. didermoides* Rost. This is much more frequent than the last named species and occurs in similar situations from June to early autumn. It has also been found in August on horse manure on a flower bed.

17. *P. cinereum* Pers. though especially a spring species may be found at other seasons also; but from March onward it has occurred plentifully on dead leaves of oak, beech, sweet chestnut, sycamore, holly, pine, poplar and bramble. Limeless sporangia almost black and iridescent are frequently met with in conjunction with the typical form.

18. *P. vernum* Somm. has been gathered in January, March and April on old leaf beds. In the spring of this year (1923) there appeared a form looking very like *Diderma spumarioides* externally; it was densely charged with lime and much nearer

the typical robust alpine kind than we usually get in England. The var. *iridescens* appeared at Oxshott and Weybridge on bramble leaves and stems in October.

19. *P. sinuosum* Weinm. The plasmodium of this species may be found fresh and preparing to fruit at least at two periods of the year, in March and October, particularly on bramble but also on the dead leaves of the horse-chestnut, sweet chestnut and beech.

20. *P. bitectum* Lister is common throughout the year on the same habitat as the preceding. It has been recorded from January to April and from July to October. A very striking and puzzling limeless form was frequently met with in April 1922 and 1923 at Weybridge and Horsley. The sporangium wall was shining iridescent, reticulated, with angular ridges and the spores were very dark and rough. It occurred on poplar and elder bark, but more usually on dead leaves especially those of sweet chestnut, beech, laurel and oak.

21. *P. contextum* Pers. and 22. *P. conglomeratum* Rost. are apparently rare and have only once been recorded in Surrey in November 1898 and September 1897 respectively, when Miss Margaret Phear found them on dead leaves at Witley.

†23. *P. mutabile* Lister was found abundantly on straw heaps near Witley in August 1905 and by Mr J. Saunders at Haslemere in 1914. It is by no means of frequent occurrence.

†24. *P. virescens* Ditmar var. *nitens* Lister. The only Surrey record of this species was made by Miss Lister at Haslemere in October 1905. It occurs on dead leaves, moss, etc.

25. *Fuligo septica* Gmel. is of common occurrence from May to October. It has been found on oak, beech, poplar, elm, pine, laurel, hornbeam, fir, bracken, grass and moss and on living alder.

var. *candida* Lister. Favours sawdust heaps of coniferous wood.

var. *rufa* Lister prefers beech and elm: the plasmodium of this variety is sometimes a pale cream colour almost white, but more often it is rich canary yellow. It has been observed in June, after six weeks drought, emerging from an apparently bone dry elm stump. The presence and thickness of the cortex depend on the atmospheric conditions prevailing at the time of development. Plasmodium maturing in sheltered situations produces no cortex; but in the open the outer sporangia wither and form a protection for the deeper layers.

†26. *F. muscorum* Alb. and Schw. flourishes on moist moorland in autumn. Two gatherings of this species have been made in Sept. 1905 at Haslemere and Morley Common on rushes, bracken and sticks.

*27. *F. cinerea* Morg. Towards the end of July 1920 a fine

development of this was noticed maturing on the stalks of living grass sprouting from an old dung heap.

28. *Craterium minutum* Fries occurs throughout the year on all sorts of decaying foliage. It has been gathered on pine needles, holly, horse-chestnut, beech, laurel, bramble, lime petioles, yew and on cones.

29. *C. leucocephalum* Ditm. appeared in July on holly leaves and abundantly in October on laurel, ivy and *Agave* stalks.

†30. *C. aureum* Rost. This beautiful little species was abundant below Hindhead in August 1917 and in July 1920 when it occurred in some profusion on alder twigs at Weybridge.

31. *Leocarpus fragilis* Link is a conspicuous species in spring and autumn growing over all kinds of dead leaves, grass and bramble. It seems to have a preference, however, for pine and fir needles.

32. *Diderma spumarioides* Fr. crops up repeatedly on rotting foliage. Especially prevalent in spring and early summer, it has been found on oak, beech, alder, bramble and laurel leaves.

33. *D. hemisphericum* Hornem. occurs on beech and horse-chestnut leaves in damp situations in April, on old straw in September and copiously on alder and bramble in October.

*34. *D. effusum* Morg. is conspicuous in February and April on sweet chestnut and rotting laurel leaves and in May on *Quercus Ilex*; in July it was very abundant on wood in a moist ditch filled with black decaying leaves, in September on birch wood and in October on rotting leaves and also among faggots.

*35. *D. deplanatum* Fr. Only once have I met this species, in the early days of my interest in Mycetozoa, when I gathered it under the impression that it was an unusually robust form of *D. difforme*. It was seated on an old oak stick and approached *D. niveum* in character, with rather more columella developed than usual.

*36. *D. montanum* Meyl. is rather a misleading name for a species not confined to mountains. The present specimen occurred on a dead pine branch lying among wet grass in October, in the woods surrounding the lake at Virginia Water. It closely resembles *D. radiatum* var. *umbilicatum* Meylan, but is distinguished by its smaller size and spores which are apt to be paler.

†37. *D. testaceum* Pers. has only once been found in Surrey when Mr Arthur Lister came across it at Witley on dead leaves in October 1896.

38. *D. floriforme* Pers. though not uncommon under oak trees in autumn, this species has only twice been recorded for Surrey, in 1906 by Professor Farmer at Wimbledon and in 1912 by Miss G. Lister at Weybridge.

*39. *D. asteroides* Lister matures from a pale creamy yellow plasmodium tinged with green. This fact was first noticed at Weybridge in a mixed leaf heap at the end of March and the beginning of April 1923. The young sporangia are of the same colour, but after twenty-four hours they turn to a bright orange yellow like those of *Badhamia foliicola*, which gives place to a *café-au-lait* tint; the sporangium on drying finally assumes a pinkish buff appearance. The outer sporangium wall is usually covered with purple tigrine mottlings which, if very numerous, may give a purple brown effect to the whole growth. Two or three hundred sporangia were found an inch or two below the surface, especially on hornbeam, beech and deciduous cypress foliage of the preceding fall.

40. *Diachea leucopoda* Rost. is of frequent occurrence between August and December on dead leaves of holly, holm oak, yew and bramble and even on dead grass. Some of the sporangia show a yellowish brown stalk.

41. *Didymium difforme* Duby. Grows commonly the whole year round on all decaying vegetable matter but seems to show a preference for sycamore leaves.

var. *repandum* G. Lister appears in Spring abundantly on sycamore, thistle and lime leaves. In March 1922 when the season was very backward a form occurred with strong warts and spines 1–3 μ long on the capillitium and spores 14 μ.

42. *D. vaccinum* Dur. and Mont. has been found in March, June and September on very rotten straw at Horsley. Most probably it could have been obtained at the same spot during the intervening months, but the distance was too great to permit more frequent visits. It was first recorded for the county by Mr E. S. Salmon on old straw at Reigate.

*43. *D. trachysporum* G. Lister has recently been published as a new species. It has been observed for the last twenty-six years and was first described under the name of *D. trochus* var. *tenue* G. Lister. It is not unfrequent among dead leaves and rotting straw from February to July but is possibly often overlooked on account of its close resemblance to *D. difforme*. The sporangia are circular or pulvinate, rather flat, sometimes forming branching plasmodiocarps. The outer sporangial wall is very frail and eggshell-like, smooth or slightly wrinkled, breaking away with the inner hyaline wall adhering to it. The spores are very dark and rough, sometimes with a prominent marked ridge; they vary in size from 8 to 12 μ; some have a very prickly aspect and in others the spines are connected at their bases by low ridges, giving an appearance, when highly magnified, of a much broken reticulation. The capillitium is variable, colourless or dark olive brown, simple, beaded, with

elliptical tips, or branching, usually with broad attachments below. This species has been found in heaps of dead leaves, especially on elm and beech, lime petioles, lime and holm oak leaves.

†44. *D. dubium* Rost. forms flat, plate-like, hemispherical sporangia or recurved plasmodiocarps of a creamy colour, rarely white, on clotted decayed leaves, especially those of ivy and less often lime and elm. The outer loose crust of crystals falls off when the inner sporangial wall enclosing the spore and capillitium contracts on maturing. In specimens gathered at Weybridge in March, April and May the capillitium was quite colourless whereas that of the type form from Lyme Regis is dark and rigid.

*45. *D. anomalum* Sturgis. This is the first European record of a species which hitherto had been found only in Colorado and near Philadelphia. In 1922 it was most plentiful from August to October on sticks of white poplar lying in faggots on the ground. The sporangia are quite sessile and pulvinate, forming irregular plasmodiocarps of from 1–15 mm. diam. The capillitium consists of a number of tubular columns enclosing small calcareous crystals, and connecting the upper and lower surface walls in such a way as to produce a striking "upholstered" appearance. The sporangial wall is firm and contains little lime, thus it is frequently of a dull chocolate colour. The spores are purple pink, spinulose, ovoid or sub-elliptical 9–12 μ. Large polygonal crystals are often present. It is strange that such a remarkable species has not been met with more frequently.

46. *D. Clavus* Rost. is frequently encountered in February, August, October and November on lime leaves. A sessile form has been found growing on moss, and a limeless form of a shining bronze colour on dead bramble was easily recognised by its small spores.

47. *D. melanospermum* Macbr. frequents coniferous woods and was abundant on pine needles at Oxshott in October 1920 and 1922.

var. *minus* Lister once appeared in August on a rotten birch branch but is more usual on dead leaves, such as those of holly, in October.

48. *D. nigripes* Fr. Has been obtained in April on beech leaves and on holly leaves and pine needles constantly in August, September and October.

var. *eximium* Lister was very prevalent at Oxshott in October 1917. It was also one of the species discovered during two hours spent on top of a haystack examining straw thatch, which is often rain sodden and rotten in places.

var. *xanthopus* Fr. is common on dead leaves in autumn

and has been found abundantly in September on the leaves of black poplar.

49. *D. squamulosum* Fr. Even this—perhaps the commonest of the Mycetozoa—is by no means always easily recognised, by reason of its extraordinary variety of forms. A completely limeless form was not unfrequent on bramble in March 1922 and near by, on old oak leaves, the same species appeared in another disguise, as flat cakes with a blue metallic sporangial wall. Quite recently I have noticed it maturing from large quantities of dull pinkish red plasmodium. A slender ridge has sometimes been seen on the spore wall.

50. *D. anellus* Morg. Only twice have I come across this species; once in October on poplar leaves among faggots, and once in March on dead holly leaves. This latter was a limeless form. It has also been recorded at Witley on rotting sycamore leaves.

*51. *D. crustaceum* Fr. has so far only been gathered once in Surrey—in April 1922—in a heap of dead leaves, selecting as its habitat pine needles, oak leaves and the foliage of *Sequoia gigantea*. The capillitium was frequently net-like as in the following species.

52. *Mucilago spongiosa* Morg. This common species should, I think, be described as common locally, or periodically, as it has only once been found in Surrey, as far back as 1898, when Miss Margaret Phear collected it at Witley in November.

*53. *Colloderma oculatum* G. Lister is best sought for in wet weather, when its opaque white or yellowish plasmodium shines out conspicuously from among darker surroundings. The mature sporangia, when of a dull dark colour, are easily passed unnoticed; but sometimes they are shining silver grey, or even brilliantly coloured in kingfisher blue. A favourite habitat of this species is on the moss *Campylopus pyriformis*, but it is also frequent on the soil between the roots of old pine stumps; on moss, liverworts and algae on pine branches, and even on bare spruce bark. On one occasion I found it on a dead leaf of Spanish chestnut. The spores are often ovoid and very variable in size. The capillitium threads have a dark purple brown interior with a hyaline sheath. The sporangia grow singly or in small clusters of three or four, or in good growths, of seven to nine. It has been recorded for every month in the year, but is especially prevalent in autumn.

54. *Stemonitis fusca* Roth. is common throughout the year especially on coniferous wood. It is one of the very few species that I have met with on Rhododendron wood.

var. *flaccida* Lister has appeared in autumn and winter on sycamore stumps.

var. *confluens* Lister. Was seen forming-up on an old horse-chestnut stump in spite of a hot August sun.

55. *S. splendens* Rost. var. *flaccida* Lister occurred in August on fir stumps near Guildford and at Witley, and on old decayed black poplar at Weybridge.

†56. *S. confluens* Cooke and Ellis. In late November 1920 the white plasmodium was noticed emerging from a piece of old bark of Lombardy poplar lying among wet grass and damp leaves. It eventually matured into three beautifully neat fascicles with the tips of the component sporangia clearly showing.

57. *S. herbatica* Peck has been found abundantly at Witley on pine stumps.

58. *S. flavogenita* Jahn was gathered in June and July on rotten fir wood, and on ground-ivy (*Nepeta Glechoma*), where the plasmodium had most probably crept from some rotting timber.

59. *S. ferruginea* Ehrenb. is frequent from May to October especially on coniferous wood. It has been reported from Weybridge and Woking, Guildford, Reigate and Oxshott.

60. *S. hyperopta* Meyl. The specific name is most appropriate as this species is surely often overlooked. On the uprooted pine stumps near the St George's Hill Golf Course, Weybridge, it has been found repeatedly in September and October. The sharp patches of reticulation on the small spores give the clue to its correct determination.

61. *Comatricha nigra* Schroet. may be gathered any day of the year on dead twigs and wood.

var. *alta* Lister is common enough in the winter months on beech and poplar branches.

62. *C. laxa* Rost. has been frequently found from March to November on old bramble stems.

†63. *C. fimbriata* G. Lister and Cran. The first Surrey record of this minute and delicate species was made near Hindhead in August 1917. In Weybridge it has been found in conjunction with *C. elegans* on a lichen covered larch stick in October, and the following month some forty sporangia were found on a decorticated pine stick. By keeping the stick moist in a tin box, further large crops were reared every month in the year. It has also been gathered on a rhododendron branch.

64. *C. elegans* Lister occurred in April on rotting ivy leaves but has more often been noticed on dead wood, especially oak, ash and larch.

65. *C. lurida* Lister. This unfrequent species has been met with but twice; in October 1896 at Reigate, and in January 1897 on dead holly leaves heaped in dry ditches.

66. *C. typhoides* Rost. is very common on rotten wood from April throughout the summer. It has been noted on poplar, alder and laurel.

67. *C. microspora* G. Lister. The only record we have of this uncommon species is due to Mr E. S. Salmon who found it on dead leaves at Reigate in October 1897.

68. *C. pulchella* Rost. Large regiments of this neat little species are of frequent occurrence in summer on dead leaves and twigs, notably those of yew and *Tsuga canadensis*.

var. *fusca* Lister has only once been met with, on the naked bark of a fallen pine branch in May.

69. *C. tenerrima* G. Lister is fairly common though less conspicuous than the last species. It has occurred on rotting grass in August, on old straw in September, on dead bramble in November, and inside dead herbaceous stems.

†70. *C. rubens* Lister. This is usually a winter species and by no means common. The only Surrey record of it was on holly and ivy leaves at Witley in October 1896.

71. *Enerthenema papillatum* Bowman seems to have a preference for rotting oak wood but is not uncommon on pine, white poplar, lime and even rhododendron. It has been found in January and March and from July to September, and also on living oak at Hindhead, five feet up the trunk.

†72. *Lamproderma scintillans* Morg. is a hardy flourishing little species not particular when or where it appears. It grows in great profusion, from January to October, covering several square yards and forming-up on anything that happens to be in its path: leaves, wood, stones, brick, etc., and even on top of other mycetozoa, *e.g. Diderma difforme* and *D. squamulosum*.

73. *L. violaceum* Rost. was seen emerging from a rotten hollow stump of Lombardy poplar in January, March and December. The delicate points of iridescent blue covering the surrounding moss, ivy leaves and sticks produced a most striking picture.

†74. *Amaurochaete fuliginosa* Rost. was observed oozing out of the parched and cracked fir and pine stumps on Oxshott heath in September and October 1921, in spite of the severe drought of that year. It was first recorded for the county at Woking, among the pines on the Common, and has since been obtained from Haslemere, Witley, Byfleet and Weybridge.

75. *Brefeldia maxima* Rost. The plasmodium of this species has been noticed in great creeping masses in April, May and June, but it is more often on the move in October and November. In no case have I met it on any but elm and poplar stumps.

†76. *Linbladia effusa* Rost. The first Surrey record of this un-

common species was made by Miss G. Lister in October 1922. At a spot on Oxshott heath where the ground is thick with pine sawdust, the dark sepia plasmodium was welling up and forming large aethalia as big as a man's hand, but so dark that, in the field, they might have been mistaken for *Brefeldia*. The month of October was exceptionally dry that year, and, had the mild weather continued, a plentiful crop would have been obtained in the following month. As it was the early frosts of November put an end to its appearance, at least for that season. This sawdust heap has yielded sheets of *Licea flexuosa* which carpeted vast areas of the ground; large patches of *Tubifera* and *Dictydium* were scattered here and there, while there was an abundance of *Cribraria argillacea, C. rufa, Ceratiomyxa* and *Trichia decipiens* together with another record for Surrey: *Cribraria pyriformis* var. *notabilis*.

77. *Cribraria argillacea* Pers. is common from July to October especially on pine and fir. In August I have found it on a yew stump year after year. A long stalked form appeared in October maturing from a lavender blue plasmodium, and large sessile sporangia, 2 mm. diam., were abundant on pine sawdust, but showed little or no appearance of net on the strong persistent cup.

78. *C. rufa* Rost. when met with is usually in large quantities. Old rotting pine wood or sawdust is its usual habitat from September to November; but at both Weybridge and Oxshott it has occurred on sweet chestnut wood and leaves.

79. *C. vulgaris* Schrad. This species is slightly earlier than the last and may be met with from August to October, not only on coniferous wood but also occasionally on yew and alder. It is by no means always an easy species to recognise, as forms with small round nodes, and large, flat, dark or pale nodes may arise in one development; but all have ochre-yellow spores and small (1 μ) plasmodic granules.

var. *aurantiaca* Pers. flourishes at the same time and on the same habitats as the typical form.

80. *C. tenella* Schrad. is a very striking and beautiful species but much less common than the last two. The tall stem, nodding sporangia and spores canary yellow in mass, at once strike the eye as something unusual. It has been found on pine in July after a fair spell of rain and also in September. Colonies of sporangia often extend over several square inches, and have been noticed intermingling with those of *Dictydium cancellatum*.

†81. *C. pyriformis* Schrad. var. *notabilis* Rex. The first Surrey record of this elusive species was made by Miss G. Lister on the prolific pine sawdust heaps at Oxshott in September 1921. The long prominent ribs make it very like *Dictydium cancellatum*

when moist, but it is always recognisable by the pink colour of the fresh spores. Throughout the whole of October last year it could be gathered in the same spot, until the beginning of November when it became attacked by mould.

82. *Dictydium cancellatum* Macbr. does not feed only on pine wood, though it is most often found there. It is of earlier appearance than the last species. In June it was found forming-up on an old alder log, supporting a melon frame. I was informed that the log had lain in the same spot exposed to the weather for over twenty years. In July, after much rain, it appeared on pine, in August on poplar, in September on beech, and in October it stretched like a carpet for several square feet over sawdust on the ground. The plasmodium, when about to fruit, was subjected to heavy rains, and irregular, though persistent, cups were formed of a beautiful transparent purple, resembling in colour the "Blue John" of Derbyshire.

var. *fuscum* Lister occurred on pine wood during a remarkably mild December in 1918.

†83. *Licea flexuosa* Pers. Every month from September to March this frequent species can be met with on moist coniferous wood. Sometimes the sporangial wall is clean, translucent and glossy but more often it is enveloped in a coating of dark refuse matter. It thrives particularly well on old pine sawdust, where I have seen it covering several square yards in close snake-like masses, folding about and blackening the soil.

†84. *Licea pusilla* Schrad. This minute and most inconspicuous species was first recorded for the county in October 1912, on St George's Hills, Weybridge. In November ten years later it was again found in that neighbourhood, on the same piece of naked pine bark as two other members of the same genus, viz. *L. minima* and *L. flexuosa*. The sporangium wall under a pocket lens frequently appears merely dull black and so faithfully agrees with the colour of the surrounding habitat as to produce a very effective camouflage. The spores were often only 14μ, sometimes 16μ and more.

85. *Licea minima* Fr. is not unfrequent wherever there are pines. I first noticed it in September on dead *Merulius* that had spread over a disintegrating pine log. The sporangial wall was deep purple brown, nearly black. In the following April a form with light brown sporangia was found near Hanscombe, the plasmodic granules on the border being almost colourless or wanting. In October and November last year, this species was very plentiful on old pine fencing lying on the ground.

86. *Tubifera ferruginosa* Gmel. It is not generally known that the plasmodium of this species may sometimes be white or

yellow though usually rose. It is abundant in September and October on pine sawdust and stumps. When old and discoloured it may resemble robust forms of *Dictydiaethalium plumbeum* or a dull ochraceous *Lindbladia*.

87. *Dictydiacthalium plumbeum* Rost. In September 1916 the beautiful pink plasmodium of this species was conspicuous, in patches over two inches in diameter, on the soft rotten trunk of an old beech. It developed into a very sturdy aethalium, being as much as 3 mm. thick in parts; the threads were very jagged on one side and occasionally had a slight frill of persistent sporangial wall. On the other hand very minute forms, no bigger than a pin's head, appeared in October on laurel faggots. In November it has been noticed on lime wood, in December on ash used as bean sticks and in April on a thick rotten stem of ivy.

†88. *Enteridium olivaceum* Ehrenb. Indistinguishable from the last in the plasmodial stage, the aethalium sometimes appears as a mere speck composed of no more than two or three sporangia or again it may extend to five or six centimetres. This latter form I have found on pine logs in November, the former on lime and larch branches in October. A glossy bottle green variety is frequent enough on lime branches; it has not the usual depressed form but is composed of rather heaped convex sporangia; it is somewhat brittle and the contents get shaken out leaving nought but the green translucent walls; in other ways it agrees with the typical form and therefore cannot claim any specific difference.

†89. *E. liceoides* Lister. This somewhat rare species has been recorded three times in Surrey: at Haslemere in October 1905, at Oxshott in 1917 and at Weybridge in September 1920 on a decorticated pine stick. The outer sporangial wall was mottled, the inner brown and glossy.

90. *Reticularia Lycoperdon* Bull. As regular as clockwork, as soon as March comes round, so soon this species appears, and from then until August it may be found frequently, on a variety of trees. I have noticed it on alder, willow, pine, poplar, cedar and birch.

†91. *Liceopsis lobata* Torrend. A crumbling old pine log half buried in the soil yielded a handsome crop of this beautiful species in September 1920. Some of the sporangia were solitary and supported on a twisted strand of hypothallus. In August 1892 it was recorded for the first time for the county, near Woking. In Weybridge it was still appearing in November and the following April another development was found within twenty yards of the former; but it was only by lifting the log out of the soil that it was discovered, as in each case it was

growing on the underside of a half buried piece of rotten pine.

*92. *Lycogala flavofuscum* Rost. On the southern side of an immense elm tree, among the little shoots at the base, the pale pink plasmodium of this species could be seen oozing out, during the third week of September in spite of nine months of phenomenal drought. It later matured into five large healthy aethalia, very inconspicuous against the silver grey bark of the tree. The following year, almost day for day, another group appeared, no longer on the living bole but inside an old hollow stump full of touch wood.

93. *L. epidendrum* Fr. A very common and attractive species and one of the earliest to be found. If the weather be not too dry it may be seen any time between March and October on decayed wood of lime, poplar, pine, chestnut, alder, etc.

*94. *Trichia verrucosa* Berk. has only twice been obtained in Surrey; at Oxshott in October 1904 and at Weybridge in March 1921. In each case it was on fir wood; the March specimens consisted of some thirty sessile sporangia, closely clustered and very suggestive of *T. favoginea*; but the granular deposits on the sporangial wall, the slender elaters and smaller meshes of the spore net, put the identification beyond a doubt.

95. *T. affinis* de Bary though common all the year round, is more plentiful in early spring and autumn on lime and poplar wood. "Hemitrichia" forms, collected after the first frosts had started in November, showed considerable variety in spore and capillitium. One had a denser network and thick-walled elaters, another extremely thick-walled elaters with a more constant series of spiral bands. The thicker elater was darker and browner than the thinner one. The reticulation of the spore though typical was traced out by very slender and shallow bands.

96. *T. persimilis* Karst. is more common even than the last. Some years it has been so abundant that one could be sure of finding it on every lime log one examined.

97. *T. scabra* Rost. This is more of a winter species and is of frequent occurrence throughout the county from October to March, especially on the wood of lime, poplar and oak.

98. *T. varia* Pers. In keeping with the specific name of this most common species one occasionally comes across some very strange forms. Not unfrequently the elaters have a double point at the end. I have seen some that branched acutely like a clothes peg, others with two prongs at right angles or again with a rounded end and two little growths like ears. In one case even some of the spores had wing-like appendages.

99. *T. contorta* Rost. has been found at Reigate and Weybridge on the bark of an overturned white poplar. It is not so

frequent as var. *inconspicua* which is fairly common in March and has even been recorded as late as May on the wood of poplar, laurel, *Acer platanoides* and especially on holly. Specimens of *Hemitrichia Karstenii*, *Perichaena corticalis* and *T. contorta* var. *inconspicua* were all found growing together on the same log of holly wood, looking so much alike that it was impossible to say, with the unaided eye, which was which.

*100. *T. alpina* R. E. Fries (= *T. contorta* Rost. var. *alpina* R. E. Fr.). It is unusual to come across an Alpine species in the lowlands of Surrey, but such was the case last April, when the first British record of this remarkable species was found on black rotting laurel leaves, in a damp ditch at Weybridge. Hitherto it has been recorded only from the mountainous heights of Sweden, Switzerland and Austria. It was not plentiful, in fact there was only one small group, consisting of three plasmodiocarps and two sporangia. It was a black, thick-walled specimen, with bright yellow, rather thick, rugged capillitium, often forming loops. The sporangium wall was composed of three layers: the innermost pale yellow and membranous, spinose or papillose; the middle one brown and horny and the outermost merely a crust of dark granular matter. The plasmodium was rich orange red; the spores 12–18 μ, minutely warted; the capillitium orange yellow 4–5 μ wide furnished with small spines and spirals studded with warts.

*101. *T. lutescens* Lister. This is one of the rarer mycetozoa and has been recorded from only five other counties so far, viz. Somerset, Worcester, Devon, Norfolk and Yorkshire. It was first found in Surrey at the end of November 1920, on a bitterly cold day with a strong north-easter blowing and frost on the ground. Nothing but the arrival of a fellow enthusiast would have induced me to go out. The little gold specks gleaming through the ice caught my eye and, eventually, some forty or more sporangia were found, scattered over a thoroughly rotten alder branch. In December the same year another large colony was discovered on the bark, and between the bark and the outer skin of waterlogged and rotten alder branches. Nearly each individual sporangium had to be cut off separately, as they are scattered and never more than three or four come together in an occasional cluster.

102. *T. decipiens* Macbr. may be gathered any month of the year on rotten wood of lime, beech, oak, etc.

103. *T. Botrytis* Pers. Common. A profuse gathering of an almost sessile and clustered form in January, on rotten alder stumps, showed a wonderful variety of tints and shades from crimson to purple black. In February the usual purple brown gregarious sporangia occurred on laurel branches, in March on

rotten lime wood and ivy leaves, and also in May, July and from October to December. The long stalked almost black specimens are more frequent on coniferous wood.

var. *flavicoma* Lister is a very instructive and interesting variety that makes two distinct appearances in the year. The spring variety is more abundant and robust than that occurring in autumn. The sporangia are sometimes mottled with dark spots, nearly always sessile, scattered or in small clusters. The plasmodium is watery white. The spores measure normally 11–12 μ and are warted, but not unfrequently they vary from 12–20 μ. The sporangium wall is mottled with granular refuse matter. The elater points taper from 20–40 μ. This variety is very abundant in April and has been gathered on leaves of beech, ivy, lime, oak, holly, beech mast, oats and twigs of gorse.

The autumn growth is usually a very tiny solitary sporangium. It has occurred on pine needles and leaves of yew, laurel and rhododendron. Very minute sporangia, invisible to the naked eye, were detected in November on dead leaves of sycamore, along the ribs on the underside of the leaf.

var. *munda* Lister. Laurel bark and old bramble stems provide the chief habitats of this variety which is frequently found in the winter months.

†104. *T. Botrytis* Pers. var. *cerifera* G. Lister was found at Horsley in October and at Weybridge in February and November, always on coniferous wood. Sometimes the sporangia are pale brown without much wax, at other times very dark, almost black, with thick deposits of wax.

†105. *T. floriformis* G. Lister. The only Surrey record of this uncommon species was made in October 1922 at Virginia Water, where it was found mixed up in delightful confusion with *Hemitrichia Vesparium*, to which it bears a very striking superficial resemblance.

†106. *Oligonema nitens* Rost. By no means unfrequent if one looks for it in the right habitat. The chief haunt of this species is wood occasionally submerged or waterlogged, but it is not averse to leaves. In Weybridge it has been found no less than twelve times. It was first reported for the county at Royal Common, where it occurred on dead oak leaves in the bed of a dry pond. It has since been found in every month of the year with the exception of January, March and April, sometimes on sodden branches of silver birch, sometimes on elder, but more frequently on alder, spreading thence for a square inch or more on to fresh grass. In October 1922 a great quantity appeared in a damp ditch on alder leaves in spite of the presence of plenty of rotting branches all round it. Some irregular developments show quite long elaters and monstrous spores completely

covered with a close reticulation of small mesh. *O. flavidum*, which should be met with in similar situations, has so far eluded the vigilance of all hunters in the county.

*107. *Hemitrichia Vesparium* Macbr. has been found at Weybridge in November, inside a decayed stump of Lombardy poplar, at Virginia Water in October and at Horsley in January on an old beech stump.

108. *H. leiotricha* Lister has only once been reported in the county, on a dead beech leaf at Witley in December 1898.

109. *H. clavata* Rost. was discovered in April at Reigate and once, but then plentifully, at Weybridge in October, on a rotting horse-chestnut trunk.

†110. *H. abietina* Lister has made only one recorded appearance in Surrey, on the trunk of a living oak, at Hindhead.

*111. *H. minor* G. Lister var. *pardina* Minakata was first met with in this county in March and April 1922, after a wet spring. The sporangia were growing on rotten stems of ivy among overhanging foliage on a rockery; on another occasion they were on rotting ivy leaves and stems lying on the ground under trees.

112. *H. Karstenii* Lister is frequently encountered on holly bark and the decaying bark of lime sticks especially in November. This species is very variable internally: some specimens collected had faint spirals on the stout walled brown capillitium, while others had pale yellow spores and capillitium, the latter, though very slender and irregular, being marked by distinct spirals.

113. *Arcyria ferruginea* Sauter is of common occurrence in autumn and winter. It has been found from March to May and from October to January on the wood of pine, cypress, oak, alder, fir, yew and larch. I once saw a pine log 4 ft. long and 9 inches in diameter almost covered with thousands of sporangia of this species, yellow forms and the more usual orange-red occurring in the same development.

114. *A. cinerea* Pers. has been met with regularly from February to November, more commonly on lime wood but also on dead leaves and even on old straw.

*115. *A. carnea* G. Lister appeared in October on rotting elder bark and lime sticks, resembling pale forms of *A. incarnata* but distinguishable by the capillitium remaining attached to the cup.

116. *A. pomiformis* Rost. At first glance this is very like a yellow form of *A. cinerea*, but the looser network of the capillitium is diagnostic and the species shows a preference for oak wood. It is frequent from May onwards and has even been recorded on living oak.

117. *A. denudata* Wettstein may be gathered any month of

the year, usually on rotten wood, sometimes on dead leaves or leathery fungi, *e.g. Polystictus versicolor* and *Trametes suaveolens*, also once recorded on living birch and once on living *Acer platanoides*.

118. *A. incarnata* Pers. has frequently been found from November to January and in March, May and July on rotten lime wood, oak or pine, etc.

var. *fulgens* Lister appears regularly every year in November and December in large patches of crimson sporangia on rotten beech.

119. *A. stipata* Lister has only once been noticed in Surrey when Mr E. S. Salmon found it on dead wood at Reigate in 1894.

120. *A. nutans* Grev. is common from June to October more especially on oak wood but also on pine, birch, rhododendron and alder.

*121. *A. Œrstedtii* Rost. makes only a brief autumnal appearance each year. It has twice occurred at Weybridge in September, once on an old pine stump and once on a piece of square cut pine timber and on adjacent leaves.

122. *Lachnobolus congestus* Lister. From January to March and from August to November this species has cropped up more than a dozen times in Weybridge. Only once was it on willow bark and in every other case it was on rotten wood of either white or Lombardy poplar. In August the fresh plasmodium was found and nursed into maturity, thus establishing its colour as opaque white, and corroborating the experience of other observers. Its favourite resort is similar to that of *O. nitens*, except that it prefers poplar wood to alder; twice it has been noticed at a height of two or three feet from the ground. The sporangia are usually heaped, rarely scattered; even then they retain a polygonal shape, showing that this feature is not necessarily due to mutual pressure.

123. *Perichaena depressa* Libert has been found frequently from February to April and from July to December on poplar bark and slender stems of yew twigs.

124. *P. corticalis* Rost. is recorded for every month except May and June. Usually it is on poplar wood but it has occurred also on rotten beech, under the bark on ash sticks and on a dead ivy stem 15 ft. up a tree.

125. *P. vermicularis* Rost. This is distinctly a winter species and has been frequently noticed every year between December and April developing from a watery pink plasmodium. It has appeared on nettle, elm leaves, hops, and the foliage of yew, bramble, holly and beech. A specimen found on a thistle, on top of a haystack, had large spores measuring 15–20 μ.

126. *Margarita metallica* Lister. This little gem is of frequent

occurrence every year from December to April, on bramble stems and wood of rhododendron, willow, laurel and pine.

*127. *Dianema depressum* Lister. I have never been successful in finding this on its favourite haunt, on ash sticks. I have even collected ash sticks in various stages of decay, and kept them in long wet grass for several years, examining them regularly, but "myxo-traps" are not usually successful. I did, at last, come across this species but only once; in March 1921 I found some five or six sporangia on a beech stick lying deep in beech leaves, under a low-growing box bush—just the place where I was hoping to find *Lamproderma atrosporum* Meyl. var. *anglicum* G. Lister and Howard. I have yet to meet the latter elusive species although I have turned over bushels of beech leaves.

*128. *Prototrichia metallica* Mass. has been gathered at Weybridge, on the bark of a fallen laurel branch in November, and on dead bramble stems in December.

The devotees of the Mycetozoa are few in number, but that is possibly because others do not realise what an absorbingly interesting study they make. No other could be more truly called an all-the-year-round hobby than this form of recreation, which, from the multifarious habitats of these little creatures, may be indulged in almost anywhere. I have lifted the snow to find *Lamproderma scintillans*, *Craterium minutum* and *Didymium squamulosum*; I have seen the little gold specks of *Tr. lutescens* shining through the icy coating of a rotten alder branch; in dripping rain, but clad accordingly, I have collected *Tr. alpina*, *Margarita* and *Colloderma*, and under a burning sun *Lycogala flavofuscum*, *Amaurochaete* and *Fuligo*; even the bleak winds of March and April fail to prevent the appearance of *Dianema depressum*, *Diderma asteroides* and *Lamproderma anglicum*.

Apart, however, from the physical and intellectual benefits, one must not forget to mention the social advantages, for the study of the Mycetozoa has introduced me to a number of fellow enthusiasts whom I am proud to rank among my very best friends. Surely, with such a hobby, one need never know a dull moment.

BRITISH LABOULBENIACEAE.

A CATALOGUE OF THE BRITISH SPECIMENS IN THE THAXTER COLLECTION AT THE BRITISH MUSEUM.

By Winifrede L. Hake.

Up to the present time there have been only two species of the Laboulbeniaceae recorded in British mycological writings, namely *Stigmatomyces purpureus* Thaxt. and *Laboulbenia vulgaris* Peyr. which were noted by Biffen in Trans. Brit. Mycol. Soc. III (1909), p. 83. There is, however, a large collection of slides of the Laboulbeniaceae in the British Museum which were presented by Professor Roland Thaxter in 1909, consisting of specimens from all parts of the world. In this collection there are twenty-six British species, five of which have so far only been found in this country, making a total of twenty-eight species. A large proportion of the specimens were collected in the suburbs of London and it seems probable that there may be many more species as yet undiscovered.

The hosts are mainly small beetles belonging to the family Staphylinidae of which the common Devil's Coach Horse beetle is perhaps the most familiar example, and others of the Caratidae which is the family that includes all the ordinary Ground beetles.

Thaxter in his 1896 Monograph describes the likely places to find the hosts, which is in the vicinity of water, under stones, rubbish, among grass roots and so on, and he further states that "5 to 50 per cent. of the hosts will be infected."

The following list gives the details of each slide and is arranged according to Thaxter's order in his second monograph. Species which have so far been recorded only from this country are indicated by an asterisk.

In order to economise space in the references "Mon. (1896)" and "Mon. (1908)" are used to refer to Thaxter's "Monograph of the Laboulbeniaceae" in the Memoirs of the American Academy of Arts and Sciences, XII (1896), and "Contribution toward a monograph of the Laboulbeniaceae, Part II," in the same publication, XIII (1908), respectively.

DICHOMYCES.

D. vulgatus Thaxt. in Proc. Amer. Acad. Arts and Sci. XXXV (1900), p. 424; Mon. (1908), p. 251, pl. XXXI, figs. 5–9.

On *Philonthus varians* Peck. Ealing. B.M. No. 359.

In the collection there are two slides both numbered 359, one of which is a co-type. The perithecium in this genus may have a "slightly recurved ear-like outgrowth," as seen in two specimens on No. 359 co-type or this outgrowth may not be developed as in the five specimens on the second slide.

[On *P. dimidiatus* Erich. Notting Hill, England. B.M. No. 761: not in the collection.]

D. hybridus Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 423; Mon. (1908), p. 253, pl. xxxi, figs. 15–19.

On *Philonthus ventralis* Grav. Ealing. B.M. No. 360.

There are three specimens on the slide showing only one type of perithecium without the ear-like outgrowths characteristic of the smaller kind.

D. biformis Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 422; Mon. (1908), p. 254, pl. xxxiii, figs. 1–5.

On *Philonthus umbratilis* Grav. Leicester. B.M. No. 362.

There is only one specimen on the slide which is stated to be immature.

CHITONOMYCES.

C. melanurus Peyr. in Sitz. k. Akad. Wissen. Wien, lxviii, Abt. i, 8 (1874), p. 250, pl. iii, figs. 30–34; Thaxt. Mon. (1896), p. 289, pl. xxvi, fig. 19; Proc. Amer. Acad. iii (1916), p. 4.

On *Laccophilus minutus* Sturm. England. B.M. No. 487. Co-type.

In all six specimens no appendages are present except that in one case broken remains of one are seen on the terminal cell of the receptacle.

C. paradoxus (Peyr.) Thaxt. in Proc. Amer. Acad. xxvii (1893), p. 32. *Heimatomyces paradoxus* Peyr. in Sitz. k. Akad. Wissen. Wien, lxviii, Abt. i, 8. (1874), p. 251, pl. iii, figs. 35–39; Thaxt. Mon. (1896), p. 287, pl. viii, figs. 17–21.

On *Laccophilus minutus* Sturm. England. B.M. No. 487 bis. Co-type.

Of the seven specimens, one shows the characteristic horn-like outgrowth of the perithecium particularly well.

MONOICOMYCES.

**M. Brittanicus* Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 413; Mon. (1908), p. 269, pl. xxxv, figs. 3 and 4.

On *Homalota insecta* Thom. Paisley. B.M. No. 455. Co-type.

The slide in the collection has four specimens.

"This species is nearly related to *M. Homalotae* and may prove only a variety. It differs in its more slender form and apparently also in the characters of the primary appendage, but more abundant and better material is needed to determine to what extent these characters are constant."

HAPLOMYCES.

H. Texanus Thaxt. in Proc. Amer. Acad. xxviii (1893), p. 160; Mon. (1896), p. 270, pl. vii, figs. 5 and 6; Mon. (1908), p. 275.

On *Bledius opacus* Bloch. Isle of Wight. B.M. No. 448. Co-type.

There are two specimens on the slide, one very perfect showing the "spine-like process" of the antheridium.

EUHAPLOMYCES.

**E. Ancyrophori* Thaxt. in Proc. Amer. Acad. xxxvii (1902), p. 25; Mon. (1908), p. 281, pl. xxxvii, figs. 19–21.

On *Ancyrophorus aureus* Fauv. Dumfriesshire. B.M. No. 1091. (Sharp collection.)

There are two species on the slide.

CANTHEROMYCES.

**C. Platystethi* Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 415; Mon. (1908), p. 282, pl. xxxvii, figs. 5–6.

On *Platystethus cornutus* Grav. Kilburn. B.M. No. 449. Co-type.

Three specimens are mounted on the slide, one perfect, showing a perithecium and a small antheridium.

"This species is most nearly related to *C. occidentalis*, which it closely resembles in general form. It is distinguished however by the greatly reduced antheridium which can hardly be made out in mature specimens, as well as by the distal enlargement of basal cell of the appendage."

POLYASCOMYCES.

**P. Trichophyae* Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 415; Mon. (1908), p. 300, pl. xxxvii, figs. 1 and 2.
On *Trichophya pilicornis* Gyl. Farnham. B.M. No. 453. Co-type.
One specimen is mounted on the slide showing the numerous asci in the perithecium and a well developed appendage.

IDIOMYCES.

I. Peyritschii Thaxt. in Proc. Amer. Acad. xxviii (1893), p. 162; Mon. (1896), p. 302, pl. ix, figs. 16–21; Mon. (1908), p. 314.
(i) On *Deleaster dichrous* Grav. British. B.M. No. 223. (Hope Coll., Oxford.)
This slide has three specimens.
(ii) Croydon. B.M. No. 451. Co-type.
This slide is not mentioned in the Monographs.

SYMPLECTROMYCES.

S. vulgaris Thaxt. Mon. (1908), p. 315, pl. l, figs. 14–16. *Teratomyces vulgaris* Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 431.
On *Quedius truncicolus* Fair. British. B.M. No. 435. Co-type.
The slide has five specimens, four of them having perithecia, antheridia and sterile appendages, the fifth lacking perithecia.

TERATOMYCES.

T. Actobii Thaxt. in Proc. Amer. Acad. xxix (1894), p. 98; Mon. (1896), p. 356, pl. x, figs. 9–17; Mon. (1908), p. 316.
On *Actobius signaticornis* Rey. Cowley. B.M. No. 439. Co-type.
"*T. Actobii* has been found in the British Museum on *Actobius cinerascens* Gr. from Merton, England, No. 438." No. 438 is not in the collection, and No. 439 is not mentioned in the Monographs.

RHADINOMYCES.

R. pallidus Thaxt. in Proc. Amer. Acad. xxviii (1893), p. 180; Mon. (1896), p. 306, pl. ix, figs. 7–11; Mon. (1908), p. 318.
(i) On *Lathrobium angustatum* Lac. Folkestone. B.M. No. 441.
Unfortunately this slide has dried and the four specimens are scarcely distinguishable.
(ii) On *Lathrobium quadratum* Puyk. Notting Hill. B.M. No. 444.
There are twenty-one specimens on this slide, one of which shows the remains of a trichogyne.

LABOULBENIA.

L. fasciculata Peyr. in Sitz. k. Akad. Wissen. Wien, lxviii, Abt. i, 8 (1874), p. 248, pl. i, figs. 8–9. *L. brachiata* Thaxt. in Proc. Amer. Acad. xxv (1890), p. 11; Mon. (1896), p. 350; Mon. (1908), p. 330.
On *Patrobus rufipes* Fabr. Britain. B.M. No. 638.
The slide has fourteen specimens mounted on it.

L. Nebria Peyr. in Sitz. k. Akad. Wissen. Wien, lxiv, Abt. i (1871), p. 455, *idem*, lxviii, Abt. i, 8 (1874), p. 249, pl. iii, fig. 29; Thaxt. in Proc. Amer. Acad. xxvii (1893), p. 45; Mon. (1896), p. 320, pl. xiii, figs. 19–21; Mon. (1908), p. 335.
On *Nebria Gyllenhalli* Sch. Whallen. B.M. No. 458.

L. stilici Thaxt. in Mon. (1908), p. 336; var. of *L. subterranea* Thaxt. in Proc. Amer. Acad. xxviii (1893), p. 163; Mon. (1896), p. 320, pl. xiii, figs. 9–11; Mon. (1908), p. 335.
On *Stilicus similis* Ev. Rathay. B.M. No. 446. Co-type.
Of the three specimens mounted one shows an antheridial appendage.

L. pedicillata Thaxt. in Proc. Amer. Acad. xxvii (1893), p. 44; Mon. (1896), p. 319, pl. xiii, figs. 4–8; Mon. (1908), p. 344.
On *Dyschirius globosus* Herbst. England. B.M. No. 349. Co-type.

Four specimens are mounted on this slide, all being of the short form as distinguished from the other form with the elongated perithecial stalk.

L. Rougetii Mont. and Robin in Robin, Hist. Nat. Veg. Par. (1853), p. 622 and Atlas, pl. x, fig. 2; Mont., Syll. Crypt. (1856), p. 250. *L. europaea* Thaxt. in Proc. Amer. Acad. xxviii (1893), p. 167; Mon. (1896), p. 310; Mon. (1908), p. 351.

On *Brachinus crepitans* Linn. England. B.M. No. 347.

Three specimens are mounted on the slide, one of which shows an antheridium on the inner appendage.

"It seems quite certain that what I previously described as *L. europaea* is in reality the species figured by Robin, although the plates are quite misleading, apparently representing individuals in which the appendages have become more or less abnormal through injury. So large a number of European Brachini have been examined on which *L. europaea* is the common species, that there seems no doubt as to the correctness of the reference." Thaxter, 1908.

**L. dubia* Thaxt. in Proc. Amer. Acad. xxxviii (1902), p. 35; Mon. (1908), p. 353, pl. lv, fig. 1.

On *Philonthus politus* Fabr. Alverstoke. B.M. No. 363. Co-type.

Of the six specimens mounted one shows the antheridia very well developed. *L. dubia* "is perhaps too near *L. rigida*, but differs in its copious appendages and in the often pronounced sub-terminal enlargement of the perithecium."

L. Cafii Thaxt. in Proc. Amer. Acad. xxxv (1899), p. 162; Mon. (1908), p. 406, pl. lxiii, figs. 1 and 2.

On *Cafia siriceus* Holme. Britain. B.M. No. 437. Co-type.

There are two specimens, one less mature, of which the antheridial appendages are very short.

"The species is well marked, being clearly distinguished by its appendages, the outer and inner eventually so displaced that they lie nearly side by side, and consisting each of a single series of somewhat obliquely superposed cells which give rise externally to simple single branches, somewhat as in the appendages of the Galerita type.... The species is remarkably constant considering its very wide distribution and is not nearly allied to any other described form."

L. Clivinalis Thaxt. in Proc. Amer. Acad. xxxv (1899), p. 165; Mon. (1908), p. 407, pl. lxi, figs. 5 and 6.

(i) On *Clivina collaris* Herbst. England. B.M. No. 348. Co-type.

This slide has six specimens, one with the appendages very well developed bearing two branchlets at the tip.

(ii) Hammersmith. B.M. No. 456. Co-type.

Two specimens on the slide.

(iii) On *Clivina fossor* Linn. England. B.M. No. 353. Co-type. (Hope Coll., Oxford.)

Six specimens on the slide.

RHACHOMYCES.

R. Philonthinus Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 435; Mon. (1908), p. 424, pl. xliv, figs. 3 and 4.

On *Philonthus* sp. British. B.M. No. 225. (Hope Coll., Oxford.)

The slide has two beautiful specimens both showing the characteristic "stigmatal markings" in the uppper cells of the main axis of the receptacle.

COMPSOMYCES.

C. Lestevi Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 439; Mon. (1908), p. 428, pl. xliii, figs. 9–12.

On *Lesteva sicula* Erich. Redhill. B.M. No. 453.

There are two specimens on the slide No. 453 (neither with antheridia).

[On *Lesteva sicula* Erich. Paisley. B.M. No. 452: not in the collection.]

MISGOMYCES.

M. Dyschirii Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 443; Mon. (1908), p. 430, pl. lxx, figs. 9–10.

On *Dyschirius globosus* Herbst. England. B.M. No. 349. Co-type. (Hope Coll., Oxford.)

EUZODIOMYCES.

E. Lathrobii Thaxt. in Proc. Amer. Acad. xxxv (1900), p. 449; Mon. (1908), p. 444, pl. lxxi, fig. 23.
On *Lathrobium punctatum* Zett. Notting Hill. B.M. No. 442. Co-type.

In concluding I wish to acknowledge my great indebtedness to Mr J. Ramsbottom for the kindly help and advice that he has given me in the preparation of this paper.

THE FUNGUS PRESENT IN LUNULARIA CRUCIATA (L.) DUM.

By W. F. F. Ridler, M.Sc.

With six figures in the text.

Historical Notes.

Kny (1879) recorded that rhizoids of Lunularia and Marchantia were frequently traversed by fungal hyphae, which possessed cross walls, branched occasionally, and were sterile. These hyphae did not reach the thallus tissue except in plants growing on rich humus, where they entered the thallus and ramified through it.

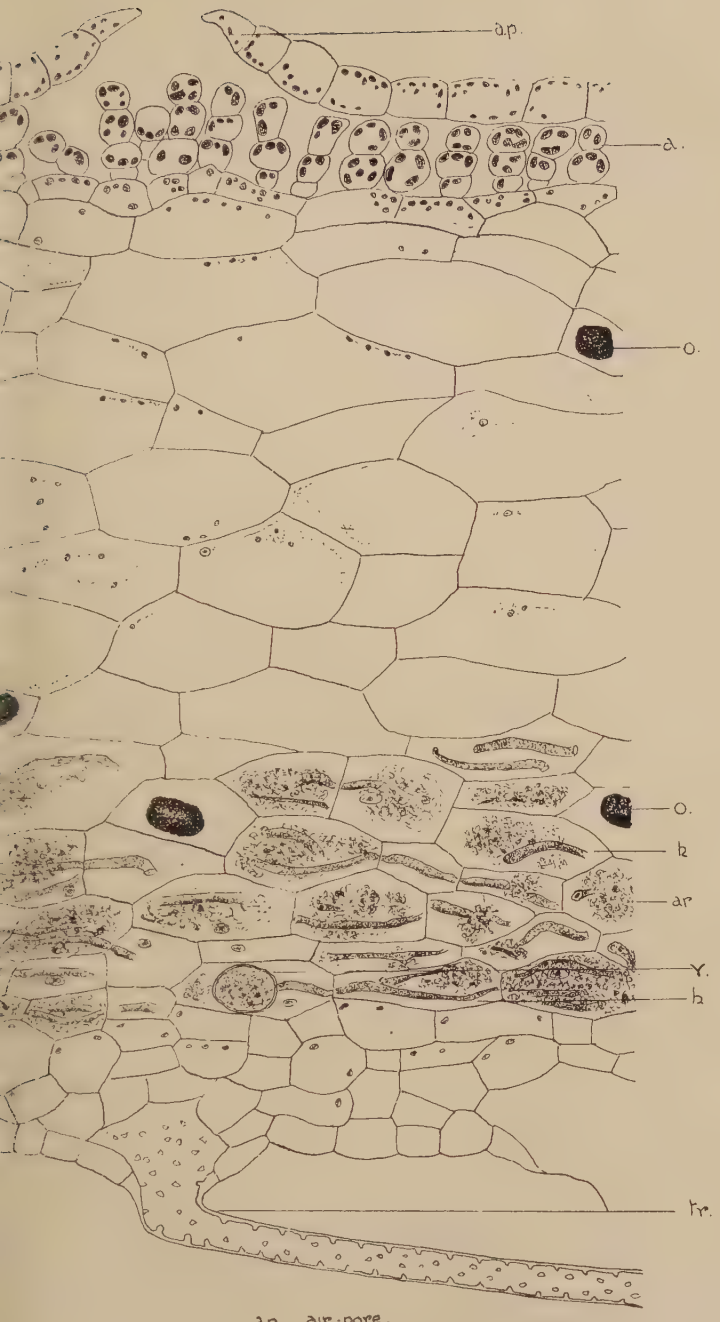
Golenkin (1902) examined numerous species of Marchantiaceae, and recorded the occurrence of endotrophic mycorrhiza in *Marchantia palmata* Nees, *M. paleacea* Bert., *Preissia commutata* Nees, *Targionia hypophylla* L., *Plagiochasma elongatum* Lindenb. and Gottsche and *Fegatella conica* Corda. He observed that cultivated plants of Lunularia as well as other members of the order were quite free from fungus and remained so although infected plants of *Marchantia palmata* and *M. paleacea* were grown in close proximity to them.

Czapek (1889) stated that Fegatella, Marchantia, and Lunularia contain an antiseptic substance "Sphagnol" in combination with the cell walls, which exerts an inhibitory influence on the growth of bacteria and moulds; Cavers (1903) suggested that the Sphagnol may serve to regulate the growth of the fungus, and so prevent symbiosis from passing into parasitism.

Presence of the Fungus.

The examination of plants of *Lunularia cruciata* from various situations has shown that, unlike those of Pellia which are always inhabited by a fungus (Ridler, 1922), they may be heavily or slightly infected by the fungus or quite free from it.

Fig. 1. Longitudinal section through the thallus of *Lunulari*



a.p. air-pore.
a. assimilating tissue.
o. oil body.
h. hyphae.
ar. arbuscule.
sp. sporangiole.
v. vesicle.
tr. trabecular rhizoid
sr. smooth rhizoid.
sc. scale.

g structure of the thallus and distribution of the fungus. × 310.

Plants growing on a decayed tree-stump in Leigh Woods, Somerset, were found to be heavily infected, but others growing in close proximity to them on a steep bank were quite free from the fungus. Some plants at a short distance from these on a gravelly path were slightly infected, but in others of the same group the fungus was absent. Plants growing on the ground among mosses in Blaize Castle Woods, Gloucestershire, were quite free from infection. Small plants of Lunularia of brownish colour from a yard of the Bristol Museum were heavily infected; the substratum upon which these were growing consisted chiefly of the dead remains of plants of the same species.

The hydrogen ion concentrations of several samples of soil upon which Lunularia was growing were measured by the colorimetric method, the experimental procedure for obtaining the soil solution used being originally described by Golas and quoted by Cavers (1914). All the soils thus tested were black loamy soils. The figures for the P_H values obtained were as follows:

Material	Method of obtaining soil solution	Indication	P_H value
From Museum (infected)	Displacement method	Phenol Red	7·8–8·0
Leigh Woods (uninfected)	,, ,,	,, ,,	7·6–7·8
Leigh Woods (infected)	,, ,,	,, ,, Brom-thymol-blue	7·4–7·6

The presence or absence of infection has apparently no connection with the degree of acidity or alkalinity of the soil. Sections of the thallus when tested showed that the P_H value of both infected and uninfected tissue were about 6·4.

The presence or absence of the fungus in Lunularia is apparently not determined by any environmental factor and its occurrence appears to be merely by chance.

Distribution of the Fungus in the Plant.

In longitudinal sections cut through the midrib of well-infected plants, the region occupied by the fungus is conspicuous as a very definite zone of brownish cells parallel to the lower surface, and in sharp contrast to the remaining colourless cells of the ventral tissue (Fig. 1). In transverse sections this fungus region is seen to consist of a single strand occupying a considerable portion of the ventral tissue of the midrib.

The hyphae enter the thallus through the rhizoids. Usually only the smooth rhizoids contain hyphae, but occasionally they have been observed in the trabecular rhizoids. In a few cases

Fig. 2. Anastomosing hyphae in a rhizoid. × 770.

when infected trabecular rhizoids have been examined these have been found to be "smooth" towards the extremity where the hyphae entered, the peg-like thickenings only being de-

veloped near the thallus. Several hyphae may pass up one rhizoid, as many as five having been observed. Cross walls are present at rather long intervals and ladder-like fusions frequently occur (Fig. 2). The fungus branches as soon as it reaches the thallus (Fig. 1), ramifies in it, and, in heavily infected plants, may extend to within 2–3 mm. from the growing point.

In slightly infected plants isolated patches of infected cells occur. These result from the entrance of hyphae into the thallus through a rhizoid immediately beneath the infected tissue. The appearance of the fungus is exactly similar to that in more heavily infected material.

Young plants, not more than 2–3 mm. in length, and developed from gemmae, were found to be heavily infected and the hyphae were similar to those in mature plants. In transverse section of such plants the fungus is seen to occupy the whole of the central portion, in some cases reaching to the base of the assimilating tissue.

Mature plants of Lunularia are normally from 20–25 cells in thickness in the thickened central portion. The lowest three or four layers of cells contain starch grains and are not occupied by the fungus except where hyphae are entering through a rhizoid. With the exception of the oil cells the six to nine layers of cells immediately above contain the fungus. From the remaining six to ten layers of cells of the ventral tissue the fungus is absent (Fig. 1). In very heavily infected plants, the infected zone may reach the base of the assimilating tissue at the wings of the midrib. The assimilating tissue is never entered by the fungus even after the plant is dead. The fungus does not occur among the gemmae. No reproductive organs of the fungus have been found on the material examined.

Behaviour of the Fungus in the Cells of the Thallus.

When sections of infected plants are examined under a high power magnification numerous hyphae are visible, passing from cell to cell. These are relatively massive, measuring from 3·5–7·5 μ in diameter, with granular contents, and are septate at long and irregular intervals. The mode of growth of these hyphae is normally parallel with the lower surface of the thallus. Apparently the cell walls of the liverwort are not injured by the fungus except at the point of penetration. The hyphae usually become constricted before piercing the cell-wall (Fig. 3), so that it is probable that penetration is effected by mechanical means, and that the cell-wall is not dissolved by a cellulose destroying enzyme.

From the main hyphae arise fine, profusely branched hyphal threads, or "arbuscules" (Bernard, 1911; Magrou, 1921) which degenerate into irregular granular masses or "sporangioles" surrounding the main hyphae (Figs. 4 and 5). This granular substance is insoluble in all the ordinary solvents, with chlor-zinc-iodine it turns a reddish-brown colour, and with iodine a yellowish-brown. The Mycosin test for chitin (Wisselingh, 1898) was tried, and after this treatment the "arbuscules," "sporan-

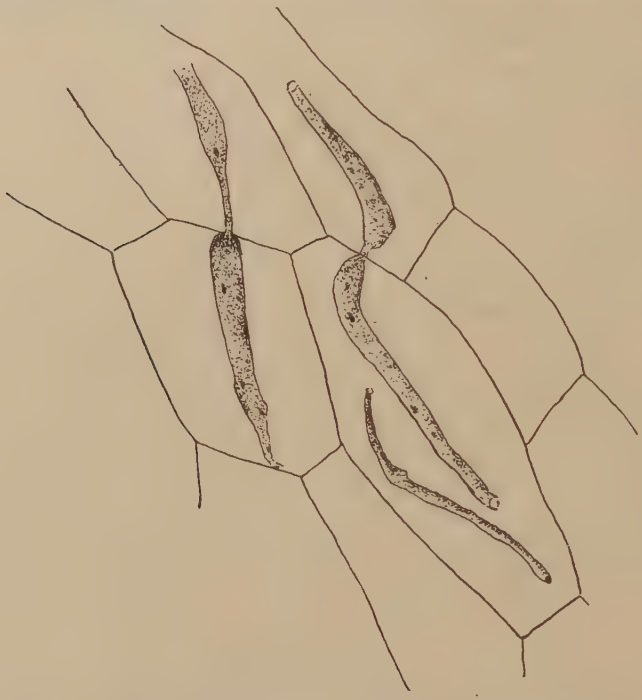


Fig. 3. Hyphae in the cells of the thallus showing method of penetration of the cell-walls. × 770.

gioles" as well as the walls of the main hyphae turned reddish-violet with chlor-zinc-iodine, while the walls of the liverwort turned blue, a similar result being obtained with iodine and a trace of sulphuric acid.

The growth of the fungus is restricted by the formation of the "arbuscules" and their subsequent conversion into "sporangioles." The infected zone is thus strictly localised, and the fungus is prevented from becoming harmfully parasitic. No marked activity of the nuclei in infected cells has been observed as has been described by Burgeff (1909), Magnus (1900) and

others as occurring in the Orchids, and by Shibata (1902) in Podocarpus. In infected cells of Lunularia however they are slightly larger than those in uninfected cells, the former measuring from 3·5–8·0 μ in diameter, and the latter from 3·5–6·5 μ, the average size in the former case being 6·3 μ, while in the latter it is 4·6 μ. In infected cells the nuclei are sometimes slightly deformed.

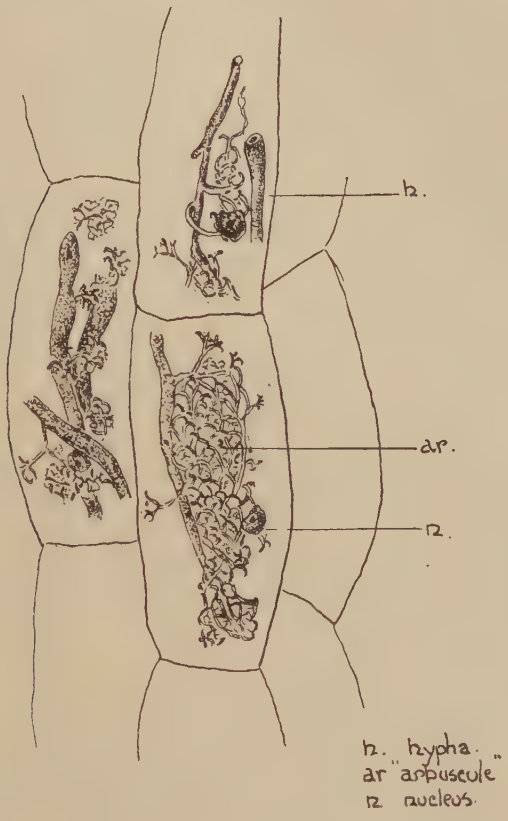


Fig. 4. Cells of *Lunularia* containing "arbuscules." × 435.

In some of the cells of the liverwort large swollen vescicles with dense contents occur, which in younger plants contain oil. In dead thalli these bodies are present in considerable numbers and possess very thick walls and dense contents. It is possible that on the decomposition of dead plants they enter the soil and germinate. When examining the rhizoids of very young plants, similar bodies were observed in close contact with them;

these had lost their contents and had germinated, sending out hyphal threads that penetrated the rhizoids and were growing in them (Fig. 6). This would seem to afford proof of the suggestion that the vescicles form a means of propagating the fungus and infecting the plants. Very few hyphae remain in the thalli of dead plants, and those that are present are for the most part devoid of contents and in various stages of disintegration.

The ventral tissue of uninfected plants of Lunularia was found to contain considerable quantities of starch. When infected thalli were examined, it was found that the cells immediately below, and those immediately above the infected cells contained starch, the infected cells themselves however contained none; it would appear therefore that the presence of the fungus is responsible for this disappearance of the starch. Stahl (1900) in his "Sinn der Mycorhizenbildung" connected the formation of starch in the thalli of Marchantiaceae with a highly developed transpiratory organisation, and the complete absence or at any rate meagre development of a mycorrhiza; while in the case of the Jungermanniaceae he connected the formation of sugar in the leaves with low transpiratory activity, and the extensive occurrence of mycorrhiza. It is now certain, however, that the occurrence of mycorrhiza in the Marchantiaceae is as frequent as in the Jungermanniaceae. Moreover, the large quantities of starch present in the former group, and also in Pellia, Fossombronia and other members of the anacrogynous Jungermanniales and which indicates, according to Stahl, vigorous transpiratory activity, does not seem to bear out his hypothesis that the amount of transpiratory activity is connected with the presence or absence of a mycorrhiza in the Hepaticae.

The presence of Sphagnol in the thallus was tested for, but it was found only in the walls of the upper epidermal cells in both infected and uninfected material; it is unlikely therefore that it has anything to do in this case with the regulation of the growth of the endophytic fungus, but more probably serves to prevent bacteria and moulds from penetrating the upper surface and causing disease.

Isolation of the Fungus.

Pieces of the thallus were teased out with a sterilised platinum needle, immersed in 1 per cent. mercuric chloride solution, washed in sterilised distilled water and placed on plates containing agar and some nutrient substance. Thick sections of the liverwort were also placed on nutrient media without previous sterilisation. All cultures were kept in the dark at

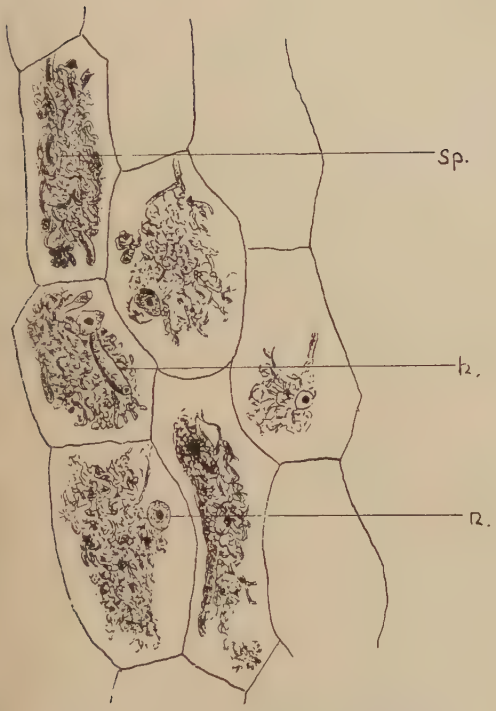


Fig. 5. Cells of *Lunularia* containing "sporangioles." × 435.

Fig. 6. Infection of young rhizoid from germinating vesicle. × 770.

room temperature. A pycnidia-producing fungus was constantly isolated during these trials. This fungus was identified as a species of Phoma but it is not the same species as that isolated from the sporophyte of *Pellia epiphylla* as its behaviour on artificial media, and the shapes and dimensions of the spores are dissimilar. Numerous attempts have been made to re-inoculate the fungus thus isolated into uninfected plants of Lunularia but these have not yet proved successful. Notwithstanding the constant isolation of the fungus in the cultures it is not certain that it is the true endophyte.

Isolation and Culture of Lunularia.

The gemmae of Lunularia being quite free from the fungus, it was found possible to obtain pure cultures of the liverwort from them. For this purpose, large test-tubes 1½ inches in diameter, were used. A quantity of nutrient liquid medium was placed in the bottom of the tube, and a strip of filter paper was introduced, which dipped into the liquid at the bottom, and covered about half the surface of the tube. The tubes were plugged tightly with cotton wool and sterilised in the autoclave.

The liquid medium used was one of those employed by Servettaz (1913) in his experiments on the development of mosses on sterilised media, namely the solution of Knop modified, as given below:

Calcium nitrate	1 gr.	Potassium phosphate	0·5 gr.
Potassium nitrate	0·5 gr.	Ferrous sulphate	0·5 gr.
Magnesium sulphate	0·5 gr.	Distilled water	1000 c.c.

Gemmae were removed from their cups with a platinum needle and sown with aseptic precautions on the strips of filter paper described above. The tubes were then placed in front of a window which faced north, so that they might be in the most favourable position with regard to light.

This method proved very successful. The gemmae were sown in December 1921, by May 1922, that is six months afterwards, they had produced very healthy thalli which in turn bore gemmae cups. By the beginning of June the gemmae produced on these plants had become scattered over the surface of the filter paper and glass sides of the tubes and in their turn had begun to germinate.

The plants on examination proved to be quite free of fungus. It is therefore certain that the liverwort can grow as well without as with it. The plants produced by this method of cultivation were larger and more healthy in appearance than any of the infected material examined. The artificial conditions of culture however might account for this. The thalli measured

from 25–35 mm. long and from 8–12 mm. broad and were bright green in colour.

Discussion.

It is very difficult to determine whether or not the fungus is of any actual use to the liverwort. The fungus apparently obtains some carbohydrate material from the liverwort; on the other hand, the partial digestion of the fungus, and the possible absorption of the contents of the latter may compensate for the loss.

The fact that the association is not constant indicates that at any rate under certain conditions in nature the fungus is not necessary for the growth of the plant, that is, the association is not obligate, but purely facultative. Reproductive organs of this liverwort are very rare, and none have been found either on infected or uninfected material used in the present investigation, so that apparently the presence or absence of the fungus has no effect on their formation. Gemmae cups are as frequent on infected as on uninfected plants. Neither is there any very definite evidence that the presence of the fungus has any effect on the size of the plants.

From these facts it appears that the fungus is of little or no use to the liverwort, and must be regarded as a harmless parasite.

Summary.

1. The cells of the thallus of *Lunularia cruciata* contain a fungus which occurs in a single strand of cells along the thickened median portion or midrib, towards the ventral surface of the thallus. The occurrence of the fungus however is not constant.

2. The fungus present undergoes partial digestion by the liverwort, ending in the formation of "arbuscules" and "sporangioles"; its growth and consequent distribution in the thallus is thus restricted.

3. Starch disappears from the cells after the entrance of the fungus.

4. A fungus has been isolated from the thallus and identified as a species of Phoma, but it is not yet certain whether this is the true endophyte.

5. Uninfected plants of Lunularia have been grown on an artificial medium.

6. The fungus obtains carbohydrate material from the thallus as a source of food material. The liverwort, on the other hand, is not apparently benefited by the presence of the fungus.

7. The association between the fungus and the liverwort is considered to be harmless parasitism on the part of the fungus.

My thanks are due to Mr C. T. Gimingham for information regarding the displacement method of obtaining soil solutions; to Mr C. Hunter for much valuable help and advice; and to Professor O. V. Darbishire for his interest in the work. During the progress of this investigation I have been in receipt of a maintenance grant from the Department of Scientific and Industrial Research.

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University of Bristol.
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THE GENUS TRICHOSTERIGMA PETCH.

By T. Petch.

In the Transactions of the British Mycological Society, VIII, p. 215, the writer proposed a new genus of *Stilbaceae*, Trichosterigma, for the reception of three species of fungi parasitic on insects. It has since, however, transpired that a genus was founded on a fungus similar to these several years ago, and the name Trichosterigma must consequently be discarded.

In 1912, Speare published an account of the fungi parasitic upon insects injurious to sugar-cane in Hawaii (Bull. No. 12, Pathological and Physiological Series, Hawaiian Sugar Planters' Association), in which he described and figured, under the heading "Sterile Cordyceps," a conidial fungus parasitic on a leaf hopper. Subsequently, Speare further investigated this and other similar fungi, and came to the conclusion that they should be included in the genus Hirsutella Pat. Speare's account of these species of Hirsutella was published in a paper entitled "On certain entomogenous fungi," in Mycologia, XII (pp. 62–76, 1920).

The genus Hirsutella was established by Patouillard in 1892 (Rev. Myc. XIV, p. 69) on a species, *Hirsutella entomophila*, which was found on an undetermined coleopteron in Ecuador. The fungus formed erect clavae, covered with scattered ovoid basidia, each basidium bearing a single elongated sterigma, with a single terminal, lemon-shaped spore. Patouillard noted that the basidia were scattered, and that there was no subhymenium, but he nevertheless regarded the fungus as a Basidiomycete, and included in the *Clavariaceae*. In his Essai Taxonomique (1900), Patouillard extended the genus to include species with tetrasporous basidia.

There does not appear to be any doubt that Speare's conclusion is correct, and that *Hirsutella entomophila*, the type species of the genus, is a Hyphomycete. Speare has also shown that the actual spore is elongated or fusiform, and that the "citriform" appearance is due to a covering of mucus deposited round the spore in such a way as to render it uniformly lemon-shaped. Spores may be found lacking this mucous covering, or it may have sagged down to the base of the spore so that the whole appears obcordate.

Trichosterigma Petch is synonymous with Hirsutella Pat. Of the species described by me (*loc. cit.*), *Trichosterigma attenuatum* Petch = *Hirsutella citriformis* Speare. *Trichosterigma clavisporum* Petch and *Trichosterigma arachnophilum* Petch must be known as *Hirsutella clavispora* and *Hirsutella arachnophila* respectively.

Throughout the tropics there occurs a fungus, parasitic on hornets, which manifests itself as long black hairs projecting in all directions from the body of the insect. This has usually been regarded as an Isaria, but solely from the fact that it grew on an insect, no one having observed any form of fructification on it. Cooke named it *Isaria Saussurei*. Speare has found that this fungus in Hawaii, California, and the West Indies is a Hirsutella, and has adopted the name *Hirsutella Saussurei* for it. The corresponding Ceylon form is also a Hirsutella, and apparently the same species. It might be considered doubtful whether this species is identical with *Isaria Saussurei*, since the clavae of the latter were said to be orange, but it would seem most probable that the colour was wrongly described.

As noted by Speare, no ascigerous stage has hitherto been recorded for any species of Hirsutella, though he considers that these forms are probably the imperfect stages of Cordyceps or an allied type. During a recent examination of a collection of Ceylon species of Cordyceps, it was found that *Cordyceps unilateralis* (Tul.) Sacc. has a Hirsutella conidial stage, the apex of the clava being at first conidial. Further, *Hirsutella arachnophila* has been found in association with a Torrubiella, and though the two have not been found together on the same stroma there is little doubt that the Hirsutella and the Torrubiella are stages of the same fungus. Speare's surmise is consequently correct.

SPORE FORMATION IN RHACODIUM CELLARE PERS.

By J. H. V. Charles.

Rhacodium cellare Pers., the fungus which covers bottles in wine cellars as with cobwebs, has been classified in standard works on fungi, *e.g.* Rabenhorst's Kryptogamen Flora, Saccardo's Sylloge Fungorum, and Engler and Prantl's Pflanzenfamilien, as one of the "Mycelia sterilia."

The volume of Rabenhorst's Kryptogamen Flora containing the description of this fungus was published in 1910, and it is somewhat remarkable that no mention is made therein of a long paper on *Rhacodium cellare* by Guéguen which appeared in the Bulletin de la Société Mycologique de France for 1906*. Guéguen clearly described a process of spore formation in this

* Attention was directed to this paper by Mr J. Ramsbottom.

fungus, thus removing the fungus from the category of "Mycelia sterilia" to the Dematiaceae.

Some time ago Mr F. T. Brooks handed me a specimen of this fungus for cultural study, and the object of this note is to call attention to Guéguen's important paper upon it and to confirm his observations upon the process of spore formation.

Spore production is readily observed in hanging-drop cultures established from a fragment of mycelium. The conidiophores are branched and bear oval conidia sometimes abstricted in chains. These conidia are capable of germination. The conidiophores are somewhat like those of *Cladosporium*, but, as with the vegetative mycelium of *Rhacodium cellare*, there is always a tendency for the constituent parts of the conidiophores to break asunder and to form independent propagative units. Figures of the spores and conidiophores are given in Guéguen's paper.

A LIST OF FUNGI &c. MAINTAINED IN THE NATIONAL COLLECTION OF TYPE CULTURES.

By R. St John Brooks, M.D., D.P.H., M.A. and Mabel Rhodes.

In the Transactions of the British Mycological Society, VII (1922), p. 237 a note appeared regarding the work of the National Collection of Type Cultures and its extension from the purely medical and veterinary side so as to include representative fungi derived from various sources. The scope of the mycological collection was made to include cultures of fungi of importance in phytopathology, medical and veterinary science, technical and soil biology, types useful for teaching purposes and any rare or interesting species.

Through the efforts of the standing committee appointed by the British Mycological Society to advise and assist the staff of the Collection in all questions appertaining to fungi, and of mycologists in various parts of the country a considerable amount of progress has already been made. The following list of fungi and of bacteria of economic interest at present maintained in the National Collection has been prepared so that the resources of the Bureau may be made available to as wide a circle as possible. The staff of the Collection are fully conscious of many important omissions and will be glad to have the assistance of members of the Society in filling in these lacunae.

The numbers given are the reference numbers of the cultures maintained in the Collection and should be quoted in all application for type cultures. A small charge is made in most cases, to cover packing and postage expenses.

All communications should be addressed to the Curator, National Collection of Type Cultures, Lister Institute, Chelsea Gardens, London, S.W. 1.

1453 Absidia cylindrospora Hagem
1312 Acanthorynchus Vaccinii Shear
789 Achorion Schoenleinii Leb.
706 Acladium Castellanii Pinoy
1491 Acrospeira mirabilis B. & Br.
1268 Acrostalagmus cinnabarinus Corda
1578 Actinomyces albosporeus Kr. [Waks. & Curt.]
1575 A. albus Kr. [Waks. & Curt.]
1574 A. aureus Waks. & Curt.
1559 A. bobili Waks. & Curt.
600 A. bovis Harz
1561 A. californicus Waks. & Curt.
659 A. caprae Silb.
1569 A. chromogenus Gasp.
1579 A. citreus Kr. [Waks. & Curt.]
1556 A. diastaticus Kr. [Waks. & Curt.]
1573 A. flavus Kr. [Waks. & Curt.]
1564 A. Fradii Waks. & Curt.
1583 A. griseus Kr. [Waks. & Curt.]
1568 A. Halstedii Waks. & Curt.
1572 A. lavendulae Waks. & Curt.
1585 A. Lipmanii Waks. & Curt.
1566 A. pheochromogenus Conn
1570 A. purpeochromogenus Waks. & Curt.
1565 A. reticuli Waks. & Curt.
1555 A. reticulus-ruber Waks.
1558 A. roseus Kr. [Waks. & Curt.]
1562 A. rutgersensis Waks. & Curt.
1563 A. scabies (Thaxter) Güssow
1577 A. Verne Waks. & Curt.
1557 A. violaceus-caesari Waks. & Curt.
1567 A. violaceus-ruber Waks. & Curt.
1582 A. 104 Waks.
1586 A. 145 Waks.
1584 A. 128 Waks.
576 A. 161 Waks.
581 A. 168 Waks.
560 A. 206 Waks.
571 A. 218 Waks.
313 Allescheria Boydii Shear
300 Alternaria panax Whetz.
301 A. Solani (Ell. & Mart.) Jones & Grout
314 Anthostomella destruens Shear
778 Aplanobacter michiganense E. F. Sm.
595 Aspergillus candidus Link
1325 A. carbonarius (Bainier) Thom
978 A. clavatus Desm.
973 A. effusus Tiraboschi
596 A. flavus Bref.
982 A. fumigatus Fres.
1326 A. fumigatus Fres. (Ascosporic)
1017 A. luchuensis T. Inui
795 A. nidulans Eidam
594 A. niger v. Tieghem
979 A. ochraceus Wilh.
598 A. Oryzae (Ahlburg) Cohn
975 A. parasiticus Speare
1324 A. pulverulentus Thom
794 A. repens de Bary
980 A. Sydowii Bain. & Sart.
599 A. tamari Kita.
981 A. terreus Thom
974 A. terricola March. v. americana March.
597 A. Wentii Wehm.
1078 Azotobacter chroococcum Beij.
Bacterium, Bacillus.
612 B. aceti Hansen
1068 B. acetoethylicum Northrop
413 B. acidi lactici Hueppe
1283 B. acidophilus Bjeloussow
1229 B. angulatum
1623 B. aptatum N.A.Br.
76 B. bulgaricus Luerssen & Kuhn
619 B. butylicus Weizm.
1650 B. butyricus Hueppe
386 B. caratovorus Jones
1381 B. caryocyaneus
1232 B. citri Hasse
1652 B. corallinus Heff.
927 B. dendroides Holzm.
1385 B. denitrofluorescens liquefaciens
1656 B. denitrificans Burri & Stutz.
912 B. fluorescens non liquefaciens Lehm. & Neum.
950 B. fluorescens liquefaciens Flügge
1174 B. fulvum Zimm.
661 B. Guentheri Lehm. & Neum.
614 B. Kuetzingianum Hans.
389 B. Lathyri Manns & Tauberhaus
1646 B. Malvacearum E. F. Sm.
1243 B. marginale N. A. Br.
654 B. megatherium de Bary

656 B. mesentericus (Flügge) Migula
1023 B. mesentericus Jordan Lloyd Type A
1024 B. mesentericus Jordan Lloyd Type B
1025 B. mesentericus Jordan Lloyd Type C
1026 B. mesentericus Jordan Lloyd Type D
1027 B. mesentericus Jordan Lloyd Type E
962 B. mesentericus panis viscosi Vogel
1098 B. mesentericus ruber Globig
1097 B. mesentericus vulgatis Flügge
1360 B. methanicus Söhn
957 B. mori Boyer & Lamb
926 B. mycoides Flügge
613 B. Pasteurianum Hansen
1543 B. phosphorescens Fischer
1404 B. prodigiosus (Ehrb.) Lehm. & Neum.
403 B. proteus mirabilis Hauser
401 B. proteus vulgaris Kruse
1376 B. radiobacter (Beij.) Lohnis
1655 B. rossicum Kell.
385 B. solanisaprus Harrison
85 B. subtilis (Ehrb.) Cohn
1231 B. tabacum Wolf & Foster
1237 B tumefaciens Smith & Townsend
1490 B. Truffautii Truffaut
1654 B. ureae Leube
1010 B. vesicatorium
1539 B. violaceus (Schroet.) Lehm. & Neum.
1242 B. viridilividum N.A.Br.
1244 B. vitians N.A.Br.
620 B. volutans Thaysen
972 B. "X" A.Br.
1375 B. xylinum A.Br.
1659 Beauveria densa (Link) Picard
1642 Blastomyces. "Sydney." Human Pathogen
1641 B. "M. H." Human Pathogen
1261 Botryosporium longibrachiatum (Oud.) Maire
1494 Botrytis Allii Munn
1142 B. Bassiana Bals.
852 B. cinerea Pers.
1189 B. cinerea Pers. Biological strain (Fig)
1075 B. cinerea Pers. Biological strain (Quince)
1138 B. Paeoniae Oud.
1448 B. pyramidalis (Sacc.) Johnson
1496 B. Tulipae (Lib.) Hopk.
1222 Catenularia fuliginea Saïto
1603 Cephalosporium Asteris Dowson
1145 C. Sacchari Butl.
1131 Cephalothecium roseum Corda
1315 Ceuthospora lunata Shear
606 Citromyces B. Wehm.
1182 Cladosporium fulvum Cooke
1649 Clostridium Pasteurianum Winogr.
884 Coccidioides immitis Rixf. & Gilchr.
1606 Colletotrichum Lindemuthianum (Sacc.) Bres.
1194 C. lincolum Pethyb. & Laff.
1130 C. phomoides (Sacc.) Chester
767 Cryptococcus farcinosus Rivolta
1294 Cytosporina ludibunda Sacc.
1184 C. Ribis P.Magn.
477 Debaryomyces globosus Klöck.
1547 Dematium pullulans de Bary
1358 Diplodia Corchori Syd.
1474 D. natalensis Evans
1133 Diplodina Lycopersici (Cooke) Hollós
703 Endodermophyton indicum Castell.
1420 Epidermophyton Pernetii Castell.
702 E. rubrum Castell.
986 Fumago vagans Pers.
1096 Fusarium coeruleum (Lib.) Sacc.
1136 F. Dianthi Prill. & Del.
1082 F. Lini Bolley
1296 F. sporotrichoides Sherb.
1454 Gliocladium penicillioides Corda
1465 Gloeosporium caulivorum Kirchn.
1317 Glomerella rufomaculans Vaccinii Shear
1318 Guignardia Vaccinii Shear
816 Hansenia apiculata Schmitz
817 H. apiculata Rees
478 Hanseniaspora valbyensis Klöck.
1319 Helminthosporium inaequale Shear
1357 H. Sacchari Butl.
705 Hemispora rugosa Castell.
1137 Heterosporium echinulatum (Berk.) Cooke
947 Lactobacillus pentoaceticus Fred, Peterson & Davenport
925 Leptothrix. Human Pathogen
1660 Metarrhizium Anisopliae (Metsch.) Sor.
1630 Micrococcus aurantiacus Cohn
1627 M. badius Lehm. & Neum.
1657 M. candicans Flügge
1628 M. concentricus Zimm.
1629 M. flavus (Flügge) Lehm. & Neum.
195 M. roseus (Rumm) Lehm. & Neum.
1631 M. sulphureus Zimm.

1489 Microsporum pubescens flavescens Kaps.
714 Monilia albicans (Robin) Zopf.
922 M. candida Bon.
698 M. krusei Castell.
697 M. macedoniensis Castell.
707 M. Pinoyi Castell.
1063 M. psilosis Ashford
696 M. tropicalis Castell.
797 M. variabilis Lindner
699 M. zeylanica Castell.
1124 Mucor hiemalis (+) Wehm.
1125 M. hiemalis (−) Wehm.
1121 M. lusitanicus Brüderlein
1120 M. mucedo Linn.
1123 M. plumbeus Bon.
1122 M. racemosus Fres.
921 M. Rouxii Wehm.
1126 M. sphaerosporus Hagem
1446 Monosporium acuminatum Bon. v. terrestre Sacc.
1470 Mycobacterium album Sohn.
1472 M. lacticola Sohn.
1469 M. luteum Sohn.
1471 M. phlei Sohn.
1468 M. rubrum Sohn.
819 Mycoderma cerevisiae Desm.
1143 Nectria diversispora Petch
1040 Nocardia indica Kanth.
576 N. lutea Christop. & Arch.
700 Oidium asteroides Castell.
701 O. rotundatum Castell.
923 O. lactis Fres.
1661 Oospora crustacea (Bull.) Sacc.
1062 Parasaccharomyces Ashfordii And.
580 Penicillium brevicaule Sacc.
581 P. brevicaule Sacc. v. album Thom
582 P. camemberti Thom
583 P. camemberti Thom v. Rogeri Thom
602 P. candidum Link
589 P. chrysogenum Thom
590 P. divaricatum Thom
593 P. expansum Link
763 P. glaucum Link
584 P. lilacinum Thom
585 P. luteum Zukal
983 P. oxalicum Currie & Thom
1151 P. pinophilum Hedg.
586 P. purpurogenum Fleroff.
588 P. Roquefortii Thom
1290 P. roseum Link
592 P. rugulosum Thom
591 P. spinulosum Thom
1321 Pestalozzia Guepinii Vaccinii Shear
1135 Phoma alterniariaceum Brooks & Searle
1383 Photobacterium phosphorium
1444 Phyllosticta prunicola Sacc.
1457 Phytophthora Cactorum (Cohn and Lebert) Schroet.
1192 P. erythroseptica Peth.
1462 P. Fagi Hart.
1463 P. infestans de Bary
1426 P. palmivora Butl.
1188 P. parasitica Dastur
1461 P. Syringae Kleb.
481 Pichia alcoholophila Klöck.
483 P. calliphorae Klöck.
901 P. farinosa Lind.
479 P. membranifaciens Hansen
480 P. polymorpha Klöck.
482 P. suaveolens Klöck.
1451 Pleurage verruculosis Jensen
1195 Polyspora Lini Laff.
1427 Pseudomonas citriputeale Sacc.
393 P. Barkeri
388 P. campestris Pammel
387 P. Hyacinthi Wakk.
958 P. Phaseoli E.F.Sm.
394 P. proteomaculans Paine
1645 P. radicicola Beij.
392 P. Tolaasii Paine
933 P. Denitrifying
499 Pseudosaccharomyces africanus Klöck.
490 P. antillarum Klöck.
497 P. apiculatus (Rees) Klöck.
492 P. austriacus Klöck.
485 P. corticis Klöck.
491 P. germanicus Klöck.
487 P. indicus Klöck.
498 P. javanicus Klöck.
494 P. Jensenii Klöck.
489 P. Lafarii Klöck.
484 P. malaianus Klöck.
496 P. Muelleri Klöck.
486 P. occidentalis Klöck.
493 P. santacruzensis Klöck.
488 P. Willii Klöck.
1308 Pyronema confluens Tul.
1175 Rhizoctonia destruens Tassi
1077 R. Solani Kuhn.
1087 Rhizopus nigricans Ehrb.
742 Saccharomyces carlsbergensis Hansen
466 S. cerevisiae Hansen (Brewing Yeast)
815 S. cerevisiae Hansen (Baking Yeast)
903 S. cerevisiae Hansen. Frohberg
909 S. cerevisiae Hansen. Logos
906 S. cerevisiae Hansen. Saaz
467 S. ellipsoideus Hansen
812 S. exiguus Hansen
905 S. fragilis Jörgensen
469 S. intermedius Hansen
472 S. marxianus Hansen
743 S. monacensis Hansen
468 S. Pastorianus Hansen
1071 S. pyriformis Ward.

1015 S. sake Yabe
792 S. thermantitonum Johnson
471 S. turbidans Hansen
470 S. validus Hansen
473 Saccharomycodes Ludwigii Hansen
814 Saccharomycopsis capsularis Schionn.
952 Sarcina aurantiaca Flügge
611 S. lutea Flügge
1323 Schizoparme straminea Shear
1014 Schizosaccharomyces mellacei Jörg.
382 S. octosporus Beij.
902 S. pombe Lindn.
476 Schwanniomyces occidentalis Klöck.
1238 Sclerotinia cinerea Schroet. forma Mali
1239 S. cinerea Schroet. forma Pruni
1072 S. fructigena (Pers.) Schroet.
1074 S. sclerotiorum (Lib.) Bref.
1593 S. Trifoliorum Erikss.
1076 Sclerotium cepivorum Berk.
1262 S. Rolfsii Sacc.
1497 S. Tuliparum Kleb.
1595 Septoria nodorum Berk.
1309 Sporodinia grandis Link
406 Sporotrichum Schenkii Hekt. & Perk.
882 S. Councilmanii Walb.
744 S. Gougerotii Matr.
1450 Stachybotrys alternans Don.
963 Staphylococcus cremoris viscosi Hammer & Cordes
1183 Stereum purpureum Fr.
662 Streptococcus acidi lactici Grot.
553 S. bulgaricus Lindn.
1304 S. citrovorus Hammer
628 Streptothrix cameli Mason
658 S. Birt-Leishman
1129 Stysanus stemonites (Pers.) Corda
1128 Thamnidium chaetocladioides Bref.
1127 T. elegans Link
1196 Thielavia basicola Zopf
1223 Thielaviopsis ethaceticus Went.
1260 T. paradoxa (de Seynes) von Höhn.
1134 Torula convoluta Harz.
1302 T. cremoris Hammer & Cordes
1492 T. histolytica Freeman & Weisman
811 Torula pulcherrima Lind.
1303 T. sphaerica Hammer & Cordes
885 T. Horse Pathogen
886 T. Human Pathogen
1452 Trichoderma Koningii Oud.
704 Trichophyton balcaneum Castell.
1116 Tyrothrix tenuis Duclaux
1181 Venturia inaequalis Aderh.
1180 V. pirina Aderh.
1545 Willia anomala Hansen
1546 W. belgica Lindn.
475 W. saturnus Klöck.
904 Yeast. "Kefir"
1639 Y. Mahua, India.
1467 Y. Mineral "Futtehefe"
608 Y. Sternberg "675"
404 Zopfius Zenkeri Rettger
813 Zygosaccharomyces Barkeri Sacc. & Syd.

ON DEMATIUM PULLULANS DE BARY.

By Ismé A. Hoggan, Bathurst Student of Newnham College, Cambridge.

In the course of certain cultural work on fungi, the writer has frequently encountered the form *Dematium pullulans* de Bary. In view of the uncertainty prevalent in recent mycological literature as to the identity of this fungus, the following note was written on the suggestion of Mr F. T. Brooks.

I. Morphological Characters of the Fungus.

The name *Dematium pullulans* was given by de Bary(1) to a fungus commonly occurring on the surface of plants and characterised by small ellipsoid conidia which were abstricted in large numbers in water or in sugar solutions from colourless, branched, septate hyphae, and which budded in the liquid after the manner of yeast cells. When the food supply was exhausted, both hyphae and bud-spores passed into a resting stage; the individual cells became rounded, with thick, dark-coloured membranes, and one or more oil-drops developed. On transference to fresh medium, the resting cells germinated after a short period, each cell sending out a single germ-tube which gave rise to hyaline hyphae abstricting fresh conidia.

The following year Loew(2) published a fuller account of the same fungus, including details of the origin and development of the conidia and the formation of resting cells, or "gemmae," in a medium such as grape-juice. The yeast-like budding of the conidia ceased with failure of the food-supply. In certain of the spores a constriction appeared in the centre, and a transverse septum arose dividing the spore into two cells. Frequently other cross-walls followed, giving rise to a chain of from three to six cells. Other spores increased greatly in size but remained aseptate. The protoplasm became vacuolate and frequently developed a characteristic oil-globule at either pole. While these changes were taking place, the cell-wall gradually thickened and darkened, assuming first a golden, then olive-green or brown hue; numerous drops of oil appeared in the protoplasm. The final stage was reached after about five or six days' culture in grape-juice.

The individual cells of the hyphae underwent similar changes. On transference to fresh medium both these and the gemmae proper sent out hyaline hyphae which rapidly proceeded to abstriction of conidia after the characteristic *Dematium* manner.

II. Systematic Position of the Fungus.

(*a*) *Relationship to* Cladosporium herbarum.

De Bary(3) does not attempt to classify the fungus beyond suggesting that it is probably nearly related to *Fumago* or *Pleospora*.

Loew (*loc. cit.*) draws attention to the striking resemblance between the uniseptate gemmae of *Dematium* and the spores of *Penicillium cladosporioides* Fres. (= *Cladosporium herbarum* Link), adding that they may be distinguished by the small papilla at the base of the *Cladosporium* spore, which is absent from the gemma; or, more surely, by their respective behaviour on transference to fresh medium. Loew further remarks upon the similarity of the resting mycelium of *Dematium* to the hyphae of *Cladosporium*. He did not, however, find any indication of a genetic relationship between the two forms, nor did he succeed in obtaining any *Cladosporium* in cultures of *Dematium*, nor *vice versa*.

These observations have a direct bearing upon the view since held by various mycologists that *Cladosporium herbarum* and *Dematium pullulans* are different forms of one and the same fungus. Thus we find that Saccardo(4) gives the latter as a stage of *Cladosporium herbarum*. In the words of Laurent(5), however, "Cette opinion n'est basée, d'après ce que m'a écrit le botaniste italien que sur l'aspect des filaments myceliens," which cannot be considered as proof of identity.

Laurent is nevertheless of the same opinion as the previous author, and sets forth at length the reasons which led him to adopt this view. His evidence has been reviewed so thoroughly by Planchon(6), however, that it seems best here to repeat in outline the latter's criticisms and refer the reader for details to the original work.

Laurent bases his conclusions on the assertions:

(i) That he observed on several occasions aerial conidiophores of *Cladosporium* developing from the mycelium of *Dematium pullulans* in culture, and

(ii) That he obtained growths of *Dematium* from cultures of spores of *Cladosporium* sown in tubes containing beerwort and placed in sunlight, while similar tubes retained in the dark gave rise to *Cladosporium*.

He also figures a conidiophore of *Cladosporium* in organic connection with a hypha of *Dematium* bearing spores (Fig. 8, p. 585); and he infers that *Dematium pullulans* is "un état affaibli du *Penicillium cladosporioides*."

Planchon examines and questions the purity of Laurent's cultures. He comes to the conclusion that the latter was in

reality dealing with a mixture of the two fungi, and shows that the results cited above are compatible with this hypothesis. For example, Laurent states that on one occasion he found conidiophores of *Cladosporium* arising from mycelium of *Dematium* in cultures of pollen grains in sugar solution, "avec lesquelles il n'était pas possible d'éviter l'envahissement par le *Dematium* des chambres humides placées sous le microscope." The *Dematium* arose as a laboratory contamination; is it not conceivable that *Cladosporium* should originate from a similar cause? The apparent development of one form into the other would doubtless be enhanced by the striking similarity between the two mycelia, to which reference has already been made. These and other facts recorded by Planchon cast grave doubts upon the purity of the cultures.

As to the development of *Dematium* mycelium in the beerwort tube cultures of *Cladosporium* spores, similar experiments repeated by Janczewski and by Planchon gave negative results. Here again Planchon invokes the hypothesis of a mixed culture; he suggests that *Cladosporium* loses its vitality relatively rapidly and supposes that this fungus perished during the prolonged exposure to sunlight so that the more resistant *Dematium* developed alone.

The more delicate task is to offer an explanation of Laurent's figure of a *Cladosporium* conidiophore in organic connection with a hypha of *Dematium*; this Planchon achieves by asserting the occurrence of growths of *Cladosporium* in which the conidia assumed an abnormal arrangement resembling *Dematium pullulans*. That is to say, the figure is believed to be based on a misinterpretation of the observed facts.

Finally Planchon argues that if *Dematium* be a weakened form of *Cladosporium*, cultivation of either type on similar media should be expected to lead in time to a convergence in the growth forms, which is contrary to fact.

In short, Laurent's evidence alone is not considered sufficiently satisfactory to warrant the assumption of a genetic relationship between the two fungi in question. It now remains to examine any further evidence brought forward in this connection.

Massee(7) ascribes a gummosis of *Prunus japonica* to an undetermined species of *Cladosporium*, and states that the disease was reproduced by inoculation of wounds with the spores of this fungus. The gummy masses exuding from the bark were found to contain hyaline hyphae and also chains of irregular dark cells, the latter on germination producing budding spores. In hanging drops and in flask cultures these brown cells gave rise to a stout, hyaline mycelium abstricting budding spores, and identified as *Dematium pullulans*. Finally, the author

asserts that fragments of sporophores of *Cladosporium* when placed in water also gave origin to the *Dematium* form of reproduction. It must be confessed, however, that this account suggests itself to the writer as one based upon a mistaken identity, in which the brown cells ascribed to *Cladosporium* were in reality the superficially similar gemmae or resting mycelium of *Dematium*. The latter fungus, being particularly abundant on the surface of plants, would be a probable contamination in these circumstances, and in the resting condition would be distinguished only with difficulty from the mycelium of *Cladosporium*.

Other writers(8, 9, 10) assert the identity of the two forms without adducing further proof.

On the other hand, Schostakowitsch(11) never found any trace of *Dematium* in cultures of *Cladosporium* or *Hormodendron*, though these were grown under varying conditions, neither did he obtain the reverse effect. Nor was Berlese(12) any more successful, and this author suggests that the discrepancy in the results of other investigators is due to contamination of the source of supply of the spores. He does not, however, deny the possibility of such relationship.

Planchon (*loc. cit*) failed equally to establish any connection between the two forms, and, more recently F. T. Brooks(13), in a systematic study of numerous strains of *Cladosporium* isolated from "black spot" of meat and from other sources, found no indication of any connection of this fungus with *Dematium pullulans*.

The writer's own observations point to the same conclusion. Cultures of several strains of *Dematium pullulans* have been studied for some months on various artificial media without disclosing any trace of associated *Cladosporium*.

To sum up, the evidence which has been brought forward as indicating a genetic relationship between the two fungi is dismissed; the existence of such a relationship is denied.

(*b*) *Relationships with Ascomycetous Fungi.*

Turning now to another class of fungi, we find certain forms among the Pyrenomycetes which possess a stage in the life-cycle so closely resembling *Dematium pullulans* as to suggest something more than a mere superficial resemblance between the two.

Such a fungus is *Plowrightia ribesia* Sacc. According to Brefeld(14) the ascospores of this fungus give rise in culture to an abundant mycelium which rapidly develops oval conidia and which presents an appearance strikingly similar to a typical growth of *Dematium*. Moreover the conidia may bud in a yeast-like manner, and, on exhaustion of the medium, gemma-forma-

tion proceeds and the hyphae assume a resting condition upon lines so closely analogous to those previously indicated when speaking of *Dematium pullulans* that Brefeld's account might be applied as truthfully to either fungus.

Similar stages occur in the life-cycles of *Sphaerulina intermixta* (B. & Br.) Sacc. and *Fumago vagans* Pers.

In dealing with *Plowrightia* Brefeld remarks: "Diese Nebenfruchtformen bieten wiederum die grösste Uebereinstimmung mit den vielgenannten *Dematium pullulans*, welches hiermit als ein Sammelname für die Conidienformen verschiedener Ascomyceten erweist"—and, in a footnote—"Dieses *Dematium*, bisher als selbständige Pilzform beschrieben, fügt sich also nicht bloss der *Sphaerulina intermixta*, sondern auch anderen Ascomyceten als Entwicklungsglied ein." That is to say, *Dematium pullulans* as such is no longer regarded as a distinct entity, but as a collective name for the conidial stage of several Ascomycetes. A similar view held by Berlese (*loc. cit.* p. 69) is expressed in the following words: "D'après les études faites, il me semble cependant qu'on puisse plus sûrement affirmer que *Dematium pullulans* est une forme collective, un état spécial d'un certain nombre de champignons non seulement sphériacés mais appartenant aussi à d'autres groupes."

To take the third-mentioned fungus first, Zopf(15) has shown that in the case of *Fumago vagans* the resemblance is a limited one, and the two fungi must therefore not be confused. The agreement is close up to the final stages of gemma-formation, but here the comparison ends. When transferred to fresh medium, the *Fumago* gemmae gave rise to a mycelium bearing pycnidia; in Zopf's words: "...nie aber gelang uns, trotz vielfach modificirter Versuche, sie" (the gemmae) "zu hefeartigen Sprossung zu bewegen; hierdurch unterschieden sie sich wesentlich von den überaus leicht sprossenden Gemmenbildung des *Dematium pullulans*, denen sie in Uebrigen täuschend ähnlich sind." This disposes of *Fumago*.

During the past year the present writer has been working with the fungus *Plowrightia ribesia*, and has attempted an investigation of the relations of this form with *Dematium pullulans*. To this end, cultures of *Dematium* were obtained from various sources—from the surface of oak twigs, from leaves of *Vinca minor*, from isolations from slime fluxes occurring in different localities, and from an old laboratory culture. All strains were grown upon various media side by side with strains of *Plowrightia ribesia* isolated from red and black currant bushes. The cultures were established in nearly all cases from the bud spores.

The six *Dematium* strains corresponded so closely in behaviour

and in morphological characters to the *Dematium pullulans* of Loew and Laurent as to leave no doubt in the mind of the writer that she was dealing with the same fungus. Slight variations in behaviour were noted at times among the different strains, but these were not considered sufficiently marked to necessitate any separation into species as Berlese suggested. On the other hand several striking differences, both macroscopic and microscopic, have been observed between the *Dematium* cultures and those of *Plowrightia*; so that, although the work is still in progress, it is hoped that a preliminary account of the cultures of *Plowrightia* will not be out of place.

(i) *Cultures on currant wood blocks*. The difference in macroscopic appearance of the two forms was here very striking. *Dematium* spores budded in great profusion on the wood, forming a white, slimy mass, which later became almost entirely black as gemma-formation proceeded. Very little or no mycelium developed; this, if present, remained sparse and white.

Plowrightia spores, on the other hand, immediately gave rise to an abundant mycelium extending over the whole surface of the wood, becoming rapidly greyish green or brown in colour and long and fluffy in texture. No trace of budding spores was found. Later, black, club-shaped organs, one to several millimetres long, appeared, possibly perithecial in nature. Nothing corresponding to this was observed in the *Dematium* cultures.

(ii) *Cultures on Dox's agar*. *Dematium* spores budded for several days forming a white, waxy mass almost bacterial in appearance. Later, hyphae developed on the surface of the slant, bearing masses of conidia. The cultures remained white for several months, or occasionally a slight blackening of the hyphae was observed.

Plowrightia spores behaved similarly at first, but the developing hyphae bore fewer or no conidia. The waxy masses rapidly coloured to a dirty yellow or black, so that the cultures could readily be distinguished from those of the former fungus.

(iii) *Cultures on currant wood-extract agar*. *Dematium* spores budded for several days, after which a superficial mycelium developed bearing masses of conidia.

Plowrightia spores behaved similarly. After about a fortnight the hyphae and spores had become very dark in colour, contrasting with the still colourless growths of *Dematium*.

Cultures were also made from portions of mycelium placed at the top of the agar slant. The subsequent growth in the case of *Dematium* was confined to the surface of the medium or deeper layers, and consisted of hyphae bearing numerous conidia. In time the mycelium darkened somewhat.

Plowrightia gave rise in addition to a dense, greenish, aerial

mycelium on the upper half of the slant, which had no counterpart in the *Dematium* tubes. The superficial mycelium darkened much more rapidly; after a few days the formation of conidia on the hyphae ceased, and in old cultures the greater part of the mycelium was found to be completely sterile.

(iv) *Cultures on beerwort agar.* These cultures also presented strikingly different appearances to the naked eye. Old *Dematium* cultures showed a black, leathery layer covering the surface of the agar, and consisting of dark-coloured hyphae and numerous gemmae. Scattered over this black layer were white, slimy masses of bud spores, and isolated patches of a short, downy, white mycelium.

The *Plowrightia* cultures also showed a black surface layer, but this consisted entirely of dark-coloured hyphae, no gemmae being observed in any part. In addition, the layer was covered by a dense, greenish, fluffy mycelium, amongst which numerous greenish or black, spherical or club-shaped pustules had developed. Other similar black pustules had arisen on the under surface of the shrunken agar.

(v) *Hanging drop cultures.* (*a*) *Currant wood-extract agar.* On agar drops *Dematium* spores budded in great profusion forming dense masses of bud cells, which spread with great rapidity over the surface of the agar. No trace of mycelium was observed until, after several days, the drop began to dry up, when a few fine poorly-developed hyphae appeared on the edge of the agar.

Plowrightia spores gave rise immediately to an abundant mycelium which soon abstricted numerous conidia.

(*b*) *Beerwort drops. Dematium* spores gave rise to a profuse, stout, hyaline mycelium abstricting masses of conidia which budded in the liquid. Gemma formation proceeded on the edge of the drop, apparently where this was beginning to dry up. In the centre of the liquid the fungus remained hyaline for a week or more.

Plowrightia spores gave rise similarly to mycelium and conidia, but these darkened rapidly throughout the liquid, and in two or three days the transformation into gemmae and resting mycelium was complete throughout.

From these observations it appears that *Dematium pullulans* and the conidial stage of *Plowrightia ribesia* are not identical. The differences shown between the two forms in culture are considered sufficiently striking to warrant the retention of the specific name for the former fungus, and recognition of it as a distinct entity.

With regard to *Sphaerulina intermixta*, the writer has not yet succeeded in obtaining material with which to carry out a similar investigation; hence the possibility of the identity of *Dematium pullulans* with this fungus is not excluded.

III. Conclusion.

The relationship of the fungus known as *Dematium pullulans* to *Cladosporium*, *Plowrightia* and *Fumago* having been examined, it is claimed that no direct connection between them exists. Reasons have been advanced for ascribing a distinct individuality to *Dematium pullulans*. To speculate as to whether there is some other perfect stage, so far undetermined, to which this fungus may eventually be ascribed, is premature, and must be left, at least, until the relations with *Sphaerulina* have been cleared up. The writer would therefore be grateful for any material of this fungus, or for suggestions of possible localities in which to search.

Finally, she desires to record her thanks to Mr F. T. Brooks for constant supervision of the work, and for much helpful advice and criticism. She is also indebted to Mr L. Ogilvie and Mr A. Smith, who supplied cultures of *Dematium pullulans*.

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STUDIES IN ENTOMOGENOUS FUNGI.

(With Plate II and five figures in text.)

III. TORRUBIELLA.

By T. Petch, B.A., B.Sc.

The genus *Torrubiella* was founded by Boudier in Revue Mycologique, VII (1885), pp. 226–7, the following generic description being given.

Torrubiella Boud. Perithecia superficial, sessile, on a thin, byssoid, membranous stroma, not borne on a clava. Paraphyses conspicuous, very slender, thickened at the apex. Other details as in the entomogenous species of *Cordyceps*.

The type specimen was collected on a spider at Montmorency in France. It was described as:

Torrubiella aranicida Boud. Perithecia elongated-conoid, subflexuose, 0·65–0·70 mm. high, 0·3–0·35 mm. diam., smooth, ochraceous or ochraceous orange, scattered or caespitose, on a thin, white, byssoid stroma. Paraphyses conspicuous, as long as the asci, very slender, apex clavate and 3 μ thick. Asci linear, very long, eight-spored, 330–350 × 5–6 μ, apex rounded and not swollen; ascospores filiform, very slender, as long as or longer than the asci, 300–400 × 0·5–2 μ, obscurely septate and granular.

Since 1885, the following species have been added to the genus:

Torrubiella tomentosa Pat. in Bull. Soc. Myc. France, VIII (1892), p. 133. On an insect (spider?) on a leaf, Ecuador. Dr Patouillard informs me that this species is on a coccid.

T. rubra Pat. and Lagh., *op. cit.* IX (1893), p. 134. On a coccid on *Melastoma* and *Solanum*, Ecuador.

T. luteorostrata Zimm. in Centralb. f. Bakt. Abt. 2, VII (1901), p. 872. On a coccid, Buitenzorg, Java.

T. rostrata P. Henn. in Hedwigia (1902), p. 167. On a moth, South America.

T. ochracea Pat. in Bull. Soc. Myc. France, XXII (1906), p. 58. On a Lepidopteron, Papeenoo, Tahiti.

T. brunnea v. Keissl. in Ann. Myc. VII (1909), p. 292. On a coccid on leaves of *Melicope*, Upolu, C. Rechinger, 5274 (Herb. Mus. Palat. Vindob.).

T. sericicola v. Höhnel in Sitz. k. Akad. Wiss. Wien, CXVIII, Abt. 1 (1909), p. 302. On cocoons of a moth, *Cricula fenestrata* Illf., Buitenzorg, Java.

T. Lecanii Johnst. in Mem. Soc. Cubana Hist. Nat. "Felipe

Poey," III (1918), p. 80. On a scale insect, *Saissetia hemisphaerica*, on *Achras Sapota*, Cuba.

T. tenuis Petch in Ann. Perad. VII (1922), p. 323. On *Aspidiotus*, *Aleyrodes*, etc., Ceylon.

T. sublintea Petch, *loc. cit.* p. 324. On an Aleyrodid, Corral, Chili.

T. barda Petch, *loc. cit.* On an Aleyrodid, Corral, Chili.

Torrubiella is a *Cordyceps* (*Torrubia*) without a clava, the perithecia being borne on a weft of hyphae, instead of being embedded in a fleshy stroma. The generic description does not reveal much difference from *Ophionectria*, and it would be expected that specimens which came into the hands of the earlier mycologists, especially those on scale insects where the entomogenous nature of the fungus is not always immediately evident, would have been placed in *Nectria*, or later in *Ophionectria*. But I have failed to detect any species of *Torrubiella* among the *Nectriae* in the herbaria of Kew and the British Museum.

On the other hand, the resemblance of the perithecia and spores to those of *Cordyceps*, coupled with the occurrence of the fungus on insects, may have led to the inclusion of species of *Torrubiella* in that genus.

Möller (Phycomyceten und Ascomyceten, 1901) declined to admit the validity of Boudier's genus *Torrubiella*. He stated (p. 144) that Boudier had separated from *Cordyceps*, as *Torrubiella*, those species which did not form a stroma outside the insect, but produced only perithecia or a loose weft of hyphae. He objected to that on the ground that there were only few such species in comparison with the total number of *Cordyceps* recorded, and nothing was gained by the separation. Of the species of *Cordyceps* described and figured by Möller, *Cordyceps flavo-viridis*, *C. cristata*, *C. rhynchoticola*, and *C. gonylepticida* appear to be *Torrubiella*. According to Möller, the last-named species has not the smallest trace of a stroma, the perithecia occurring on the insect without any film of mycelium; hence he concluded that his species was different from *Torrubiella aranicida* Boud. Perithecia which have only a very slight basal weft of hyphae do, however, occur in species which have normally a well-developed byssoid stroma, and so the character on which Möller relied may not be constant.

Möller further objected that the genus *Torrubiella* was not well founded, because of the existence of transitional forms between *Torrubiella* and *Cordyceps*. In *Cordyceps flavo-viridis*, the perithecia are situated on repent strands of mycelium spreading from the floccose stroma which covers the host insect; Möller pointed out that in this condition the fungus was *Torru-*

biella, but if the strands should happen to become erect it would be *Cordyceps*. He also described and figured a species, which had been named *Cordyceps Moelleri* by Hennings, in which the clavae were composed of parallel hyphae, and the perithecia were not sunk in the clava.

Support of Möller's objection is afforded by a species, *Torrubiella ochracea* Pat., which occurs on an undetermined Noctuid in Ceylon. In three examples of this species, collected on different occasions, there are no clavae; the perithecia are situated on a weft of hyphae which covers parts of the insect, or on places where no external stroma is visible. In another example, however, sixteen processes arise from the insect. These are up to 5 mm. high, usually laterally compressed, up to 1 mm. broad, with dense clusters of perithecia at their apices. The processes are composed of more or less parallel hyphae, firmly adherent to one another, and the perithecia are superficial. In other respects, including the conidial stage, the specimens are identical, and there does not appear to be any room for doubt that they are the same species (Plate II, figs. 11, 12).

From Möller's figures, *Cordyceps cristata* Möller and *C. Moelleri* P. Henn. would appear to offer a parallel case. Both are on a Noctuid and have yellow perithecia. The perithecia differ in size, those of *C. cristata* being 300–500 μ high, according to Möller, and those of *C. Moelleri* up to 700 μ high, but this variation is not greater than that in the *Torrubiella* forms of *T. ochracea*. In *C. cristata* the perithecia are situated on a loose stroma overrunning the body of the insect; in *C. Moelleri* they are grouped on erect clavae, up to 1·5 cm. long, composed of parallel hyphae. In Möller's figure 80 (*C. Moelleri*) the perithecia are clustered and appear free, but the description states that they are more or less embedded in the clava, up to one-third their height.

Tranzschel, in Hedwigia (1899), p. (11), instituted the genus *Helminthascus* for a fungus found on a spider in Russia. The perithecia were totally immersed in a flattened pulvinate stroma. Saccardo, in Sylloge Fungorum, XVI (1902), p. 616, wrote that the genus "fere absque dubio cum gen. Torrubiella collidit": that would appear to depend upon the character of the structure described as a stroma (cf. *Torrubiella barda* and *T. sublintea*).

Barya montana Rac. in Bull. Acad. Sci. Cracovie (1907), p. 909, would appear from the description to be *Torrubiella*. Raciborski placed it in *Barya*, in preference to *Torrubiella*, because it had no paraphyses. It occurred on a spider in Java, and was said to have a *Stilbum* conidial stage. The common conidial fungus on spiders in Ceylon is *Gibellula*, but it has not been possible to connect that with any *Torrubiella*. On the other hand, *Torrubiella flava*, which occurs on spiders, has

a *Stilbum*-like conidial stage, which belongs to the genus *Hirsutella*.

There are known, therefore, the following species, which have either been recorded as *Torrubiella*, or should probably be referred to that genus.

On spiders—*Torrubiella aranicida* Boud., *T. flava* Petch, *Cordyceps gonylepticida* Möller, *Helminthascus arachnophthorus* Transzch., and *Barya montana* Rac.

On *Lepidoptera*—*Torrubiella rostrata* P. Henn., *T. ochracea* Pat., *T. sericicola* v. Höhnel, and *Cordyceps cristata* Möller.

On *Rhynchota*—*Cordyceps rhynchoticola* Möller.

On undetermined insects—*Cordyceps flavo-viridis* Möller.

On "Coccids"—*Torrubiella tomentosa* Pat., *T. rubra* Pat. and Lagh., *T. luteorostrata* Zimm., *T. brunnea* v. Keissl., *T. Lecanii* Johnst., *T. tenuis* Petch, *T. sublintea* Petch, and *T. barda* Petch.

The present account deals chiefly with the last group. It is based on a series of specimens collected in Ceylon and the Eastern Tropics, and others from South America kindly furnished by Professor Thaxter.

Very many of the species of the genus *Cordyceps* have been described from single specimens, and, except in the case of a few well-known species, the herbarium material is scanty, or is represented in one herbarium only. The host insect, in many cases, is not gregarious, and it may happen that only one example of the fungus can be found. The same is true of the species of *Torrubiella* on *Lepidoptera* and *Arachnida*. The latter are usually found, in the tropics, on the under side of leaves, attached to the leaf by a weft of mycelium, and under such circumstances, seeing that the insects can travel about at random, it is scarcely to be expected that a number of examples of the fungus will be found together.

In one locality in Ceylon, however, there is a marked exception to the theory just enunciated. The species concerned is *Cordyceps dipterigena* B. and Br. It is found in the jungle at Hakgala, where it occurs on flies which are, as a rule, attached to the lower side of small branches or the under surface of leaves, and if one searches carefully, if one be found, there are usually at least half a dozen. That has been my experience on several occasions during the last twelve years, and circumstances suggest that the insects are infected during the period when they are in close association, *i.e.* in the larval stage.

Species of *Torrubiella* on scale insects (including *Aleyrodidae*) can usually be collected in fair quantity, when they do occur, because, in general, large numbers of the insects occur together on the same host plant.

As illustrative of the scantiness of the herbarium material of *Torrubiella*, it may be noted that up to the end of 1920, neither the Kew nor the British Museum herbarium contained a specimen under that name, nor, apparently, under any other genus, notwithstanding the richness of both herbaria in tropical fungi.

I have not seen the type specimen of the genus *Torrubiella*, *T. aranicida* Boud. The other species which have been placed in Boudier's genus do not appear to agree with the original generic description on several points, though it is scarcely to be doubted that they are co-generic. Only a re-examination of the type can decide whether these discrepancies are real or not.

Boudier described his species as having paraphyses, and included the presence of paraphyses as a generic character. Patouillard described *T. tomentosa* Pat. and *T. rubra* Pat. and Lagh. as not having paraphyses, and did not refer to paraphyses in *T. ochracea* Pat. Zimmermann did not mention paraphyses in the description of *T. luteorostrata*, nor did Hennings in the description of *T. rostrata*. von Keissler stated that *T. brunnea* had few, filiform paraphyses, sparsely guttulate, with a slightly capitate apex. von Höhnel described *T. sericicola* as having very delicate evanescent paraphyses, shorter than the asci, and added that paraphyses were present, but were not typically developed. Möller did not mention paraphyses in his descriptions of *Cordyceps gonylepticida*, *C. rhynchoticola*, and *C. cristata*, and Tranzschel stated that he did not observe paraphyses in *Helminthascus arachnophthorus*.

I have not been able to identify paraphyses in any of the species which are parasitic on scale insects. The paraphyses described by von Keissler for *T. brunnea* would appear to be immature asci. But in *Torrubiella flava*, which is parasitic on spiders, there are thin-walled paraphyses, as long as the asci, lax, collapsing, with protoplasmic contents, expanding to a breadth of 3μ at the apex. They resemble immature asci, but they do not possess a thickened cap.

The perithecium of *Torrubiella*, in some species, contains a comparatively large amount of an amorphous jelly-like substance, in which are embedded minute fusoid granules and sometimes more or less spherical cells. This substance at first sight might be regarded as the product of diffluent paraphyses. If, however, the perithecium is subjected to pressure under a cover glass, the mass of asci, if ripe enough, will be extruded through the base; and it is then found that the amorphous substance forms a continuous layer round the asci, and prevents them from spreading out separately, or in the usual fan-shaped manner, on the slide. It does not occur between the asci. At

the same time, the contents of the neck of the perithecium may be forced through the ostiolum, and these may issue in the form of a continuous sheet in which the periphyses are clearly distinct. It would appear from these observations that the amorphous mass is formed by the disintegration of the inner layer of the wall of the perithecium, not from a peripheral zone of paraphyses.

Boudier described the apex of the ascus as rounded and "non-tumente." The apex of the ascus in the species available to me is capitate, as in *Cordyceps* and *Hypocrella*, *i.e.* it is strongly thickened, with a more or less transverse base. In the original descriptions of *T. tomentosa*, *T. rubra*, and *T. ochracea*, the apex is described as capitate; in *T. rostrata*, as tunicate; in *T. luteorostrata*, as thickly tunicate; in *T. brunnea*, as thickened; and in *T. sericicola*, as a hemispherical slime cap, 3 μ broad. Tranzschel stated that in *Helminthascus arachnophthorus* the apex of the ascus was thickened, while Raciborski described that of *Barya montana* as thick-walled and conical.

The perithecium in the available specimens of *Torrubiella* is usually elongated conoid, or elongated flask-shaped, in the latter case with a comparatively long neck, which in the dried specimens often becomes recurved or irregularly bent, as noted by Zimmermann in *T. luteorostrata*, and by Hennings in *T. rostrata*. The perithecium is usually clothed for about two-thirds its height with hyphae, arising both from the stroma and the wall of the perithecium. If this covering is removed, the wall, when mounted, is found to be composed of interwoven hyphae, which form a parenchymatous tissue, but run more or less circumferentially round the perithecium. Probably because of that, the perithecia readily break transversely; and old herbarium specimens may have lost the upper part of the neck (and hence exhibit a "widely open ostiolum"), or may retain only the cup-shaped base of the perithecium. The inner layer of the perithecium wall is usually thick, hyaline, and obscure in structure.

On *Lepidoptera* and *Arachnida*, *Torrubiella* usually permeates the body of the insect and clothes it with a weft of hyphae; and the perithecia are produced on this weft, embedded in it to various depths up to about two-thirds their height, or on parts of the insect which do not show any superficial mycelium, except a slight weft at the base of the perithecium. On scale insects, these fungi similarly permeate the host insect, and then form over it a stroma of loosely interwoven hyphae, which may be pulvinate, up to 3 mm. in diameter, with a broad, spreading hypothallus. The perithecia may be borne on the stroma, or at its margin on the hypothallus, or anywhere on the hypo-

thallus. But on the same leaf there may occur perithecia which have no visible stroma, but only a slight attaching weft of hyphae at the base. Barren stromata of *Torrubiella* are most annoyingly common.

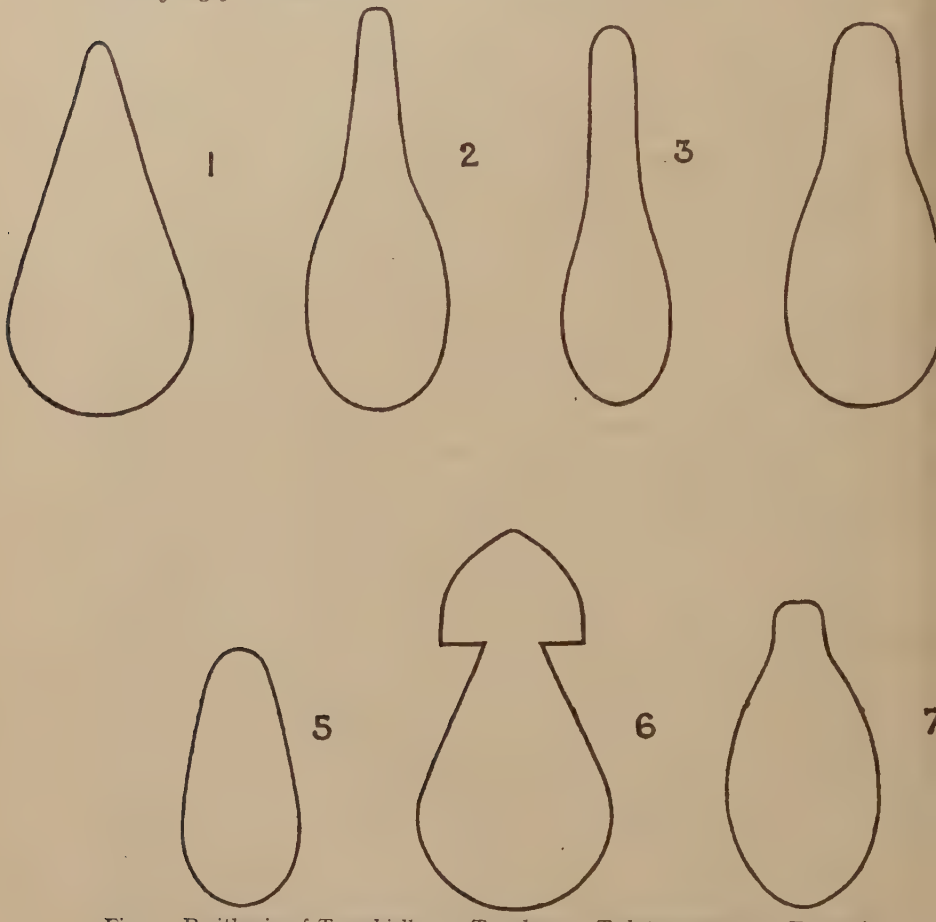


Fig. 1. Perithecia of *Torrubiella*. 1. *T. rubra*; 2. *T. luteorostrata*; 3. *T. tenuis*; 4. *T. sublintea*; 5. *T. tomentosa*; 6. *T. barda*; 7. *T. ochracea*. All ×33.

In the first stage of formation of the stroma in the scale-insect species of *Torrubiella*, the hyphae are thin-walled, about 2 μ diameter, with numerous very fine hyphae, 0·5–1 μ in diameter, encrusted with globose, hyaline granules. These fuse into a membranous sheet, here and there hyaline and amorphous, which constitutes a basal disc which attaches the fungus to the leaf. The hypothallus retains this structure, with the addition

of some thick-walled hyphae, but the mass of the pulvinate stroma subsequently formed consists, in general, of thick-walled hyphae, flexuose and irregularly intertwined. In some cases, the hyphae on the surface of the stroma tend to fuse into a continuous, glabrous sheet; this is well-marked in species from the American tropics. In the only available species on *Lepidoptera*, the hyphae of the stroma are thin-walled.

The asci are very long, cylindric, narrow, with a capitate apex. They contain usually eight linear ascospores, more or less spirally arranged, and as long as the ascus. These become septate and subsequently divide into cylindrical part-spores, which may become rounded at the ends and narrow-oval. This division into part-spores has been recorded in *T. tomentosa*, *T. rubra*, *T. sericicola*, *T. ochracea*, *T. Lecanii*, *Barya montana*, and *Helminthascus arachnophthorus*. On the other hand, Boudier did not find part-spores in *T. aranicida*, nor did Hennings in *T. rostrata*. Zimmermann stated that he did not observe septation or the formation of part-spores in *T. luteorostrata*, and von Keissler recorded the ascospores of *T. brunnea* as continuous and apparently not dividing.

Among the many unexplained phenomena attending fungi parasitic on scale insects, perhaps the most notable from the systematic standpoint are the comparative rarity of the ascigerous stage in *Hypocrella* and *Sphaerostilbe*, and the rarity of occurrence of fully ripe perithecia when the ascigerous stage is found in *Hypocrella* and *Torrubiella*. In the latter two genera the hyphae of the stromata are sclerotioid and adapted to withstand periods of drought; it may, perhaps, be suggested that these fungi may be subject to, and survive, a cessation of growth at any stage, and that the spores are only matured and ejected from the perithecium under certain limited weather conditions. Certainly, the majority of the collections of *Hypocrella* and those of *Torrubiella* on scale insects contain only immature asci. Under such circumstances, descriptions of the ascospores based on a single collection can be correct only by a lucky chance.

In the specimens examined by me, septate ascospores have been commonly observed. Loose part-spores have been seen, *i.e.* not in an ascus, and also part-spores in asci, the greater part of the contents of which appeared to have become disorganised. But I have not been able to find the stage which was expected, that which has been frequently seen in *Hypocrella*, in which the separate part-spores are arranged in the asci in lines corresponding to the original undivided ascospores. It appears, however, to be quite certain that the ascospores of *Torrubiella* divide into part-spores within the ascus.

In Revue Mycologique (1887), p. 158, Boudier described

a conidial form, *Isaria cuneispora*, on a spider, from the same locality as *Torrubiella aranicida*. The fungus covered the insect with a white, effused weft of mycelium, composed of interwoven, branching, septate, minutely granular hyphae. The sporiferous hyphae were erect, 600–700 μ high, 2–3 μ diameter, simple, or branched once or twice, and bore solitary hyaline conidia, elongated conical, 12–14 × 2–2·5 μ, attached at the thicker end. The description of the spore suggests *Hirsutella*.

Conidia were recorded by von Höhnel in *Torrubiella rostrata*. They occurred on ovoid, apiculate, conidiophores on the upper part of the perithecium, and were yellowish, ellipsoid, 3·5 × 3 μ.

Conidia have been observed by me in five species, viz. *T. rubra*, *T. sublintea*, *T. tomentosa*, *T. ochracea* and *T. flava*. In the first of these they are borne laterally on repent hyphae, densely crowded along the hyphae, and are hyaline, oval, 3 × 1·5 μ, or spherical, 2 μ diameter. In the second, the conidia are very variable in shape, fusoid, three-septate, ends acute but not produced, 18–24 × 4 μ, or five-septate, with tips strongly attenuated and slightly curved, 36–46 × 3–4 μ, or seven-septate, falcate, ends equally curved and attenuated, 43 × 4 μ, the last being a typical, uniformly curved *Fusarium* spore; they are borne laterally on simple hyphae, sometimes close together and forming a cluster. In the third and fourth species the conidia occur laterally on the hyphae, and are oval or globose, and spinulose. In the fifth species, the conidiophore is *Stilbum*-like, and belongs to the genus *Hirsutella*.

Of the species of *Torrubiella* parasitic on scale insects, *T. brunnea* v. Keissl. appears to be identical with *T. luteorostrata* Zimm. It has not been possible to compare the species on scale insects with those recorded on spiders, *Lepidoptera*, etc., owing to the inaccessibility of the type specimens of the latter. The species which occur on scale insects in Ceylon are different from the species discovered on other insects in that country, viz. *T. ochracea* Pat. and *T. flava* Petch.

The species on scale insects may be arranged as follows:

Perithecia purple-red, elongated conoid; stroma pinkish becoming pale brown.	*T. rubra*
Perithecia purple-red, elongated flask-shaped; stroma purple-red (rarely white), becoming purple-brown, yellow-brown, or Sanford brown.	*T. luteorostrata*
Perithecia pale ochraceous or amber, elongated flask-shaped; stroma white.	*T. tenuis*
Perithecia brownish-yellow, elongated conoid; stroma white.	*T. sublintea*
Perithecia yellow, ovato-conoid; mycelium on perithecium with free clavate tips.	*T. tomentosa*

Perithecia orange-yellow, conoid; apex red-brown, capitate; stroma orange-yellow. *T. barda*

Perithecia vivid yellow, conoid. *T. Lecanii*

Torrubiella rubra Pat. and Lagh. in Bull. Soc. Myc. France, IX (1893), p. 154.

Stromata flattened pulvinate, up to 2·5 mm. diam. pinkish red, usually with a thin, white, superficial layer, becoming pale brown, tomentose, compact internally, generally surrounded by a thin, white, powdery hypothallus which extends over the leaf for several millimetres.

Perithecia produced on the hypothallus, irregularly distributed, solitary or in groups (but not united), elongated conoid, 0·65–0·8 mm. high, 0·3–0·4 mm. diameter below, purple-red, dark-red by transmitted light, apex brownish, clothed below with interwoven hyphae arising from the stroma and from the perithecium wall up to two-thirds the height of the perithecium, the hyphae from the perithecial wall tending to be moniliform; asci long, cylindrical, capitate, eight-spored, 7 μ diameter; spores filiform, as long as the ascus, septate, dividing into cylindrical part-spores, 4–6 × 1·5–2 μ.

Conidia on repent hyphae, 2 μ diameter, on the surface of the stroma and hypothallus, lateral, solitary on minute crowded pedicels, hyaline, oval, 3 × 1·5 μ, or spherical, 1–2 μ diameter.

Fig. 2. Conidia of *T. rubra*. ×2000.

Ecuador, on a coccid on *Melastoma* and *Solanum* (Patouillard and Lagerheim). Corral, Chili, on an Aleyrodid, December 1905 (Thaxter). (Plate II, fig. 1.)

The above description is drawn up from Thaxter's specimen; only one stroma bore the conidial stage, but the conidia on that were so abundant that in places they were massed together in flakes; the collection contained numerous barren stromata.

Patouillard and Lagerheim gave the dimensions of the asci as 700–800 × 6–7 μ, the part-spores 3–5 μ long, and the perithecia, up to 1 mm. high; they stated that the stroma was white, then rose, red, or rufous-brown. In describing the colour as above, the sequence has been deduced from the changes in the corresponding Ceylon species.

The stroma consists of interwoven hyphae which are not fused into a solid or parenchymatous tissue. The hyphae in the interior are thick-walled or almost solid, flexuose, 3–4 μ diameter, irregular, sometimes attaining a diameter of 5 μ, generally rough with minute granules. At the exterior the hyphae are of the same character, 2–5 μ, occasionally 6 μ diameter, with, in addition, very fine hyphae 0·75 μ diameter. The fine hyphae

and the granules tend to fuse into a hyaline sheet, as in the hypothallus, but this is not continuous over the stroma in the available specimens, and the surface of the stroma usually appears tomentose. The inner hyphae are more densely interwoven than those at the exterior.

By transmitted light, the hyphae appear only feebly coloured. In the pink stromata, they are red or red-brown in mass, but only faintly tinged pale red when isolated. In the brown stromata, the hyphae are faintly tinged yellow. The hyphae on the perithecium are often closely septate.

Torrubiella luteorostrata Zimm. in Centralb. f. Bakt. Abt. 2, VII (1901), p. 872; *Torrubiella brunnea* v. Keissl. in Annales Mycologici, VII (1909), p. 292.

Stromata pulvinate, flattened pulvinate, ring-shaped, or discoid, up to 1·5 mm. diameter, purple-red, becoming purple-brown, yellow-brown, or Sanford brown, rarely white, tomentose, rather loose internally, surrounded by a white, byssoid or powdery hypothallus.

Perithecia produced on the stroma or the hypothallus, scattered or clustered, sometimes solitary without any stroma except a slight basal weft of hyphae, elongated flask-shaped or elongated conoid, 0·6–0·9 mm. high, 0·25–0·3 mm. diameter, purple-red, red-brown by transmitted light; neck 0·08 mm. diameter, at first dark purple-red, becoming yellow when mature, decurved or twisted in herbarium specimens; perithecia usually clothed with purple-red hyphae up to two-thirds their height, rarely almost glabrous; asci long, cylindrical, capitate, eight-spored, 7 μ diameter; spores filiform, as long as the ascus, septate, dividing into cylindrical part-spores, 3–6 × 1 μ.

Java; on a coccid, Buitenzorg (Zimmermann). Upolu; on a coccid on leaves of *Melicope* (*T. brunnea* v. Keissl.) C. Rechinger No. 5274, Herb. Mus. Palat. Vindob. (von Keissler). Ceylon; on an Aleyrodid on *Tetranthera*, Pundaluoya, Feb. 1889, coll. E. E. Green (Parkin, Torrubiella, 1, p. 18); on *Aspidiotus* on *Strobilanthes* sp., Hakgala, Sept. 1908; on *Fiorinia rubrolineata* on *Saprosma zeylanicum* Bedd., Hakgala, May 1910; on *Aspidiotus destructor* on *Loranthus* sp., Hakgala, May 1910; on *Fiorinia* on *Murraya exotica* L., Hakgala, May 1910, April 1917; on an Aleyrodid on *Saprosma zeylanicum* Bedd., Hakgala, May 1912; on an Aleyrodid on *Allophylus zeylanicus* L., Hakgala, May 1912; on a black Aleyrodid on *Pavetta indica* L., Hakgala, January 1914; on an Aleyrodid on an undetermined host plant, Hakgala, April 1917; on a black Aleyrodid on *Hedyotis verticillaris* W. and A., Nuwara Eliya, December 1917; on an Aleyrodid on *Psychotria elongata* Hk. f., Hakgala, April 1919. Seychelles, on an Aleyrodid on *Cyperus* sp., Mahe, coll. R. Dupont (Plate II, figs. 2–5).

I have not seen the type specimen from Java, nor Rechinger 5274, nor the specimen recorded by Parkin (p. 19), on an Aleyrodid on a jungle tree, Pusella, Ceylon, February 1899.

Immature examples of the perithecia of this species are not as tall as the mature form, and the apex, as noted by Parkin, is dark purple, almost black. The characteristic yellow subtranslucent apex apparently is not developed until the perithecium is nearly mature (Plate II, fig. 3).

The stroma is looser than in *T. rubra*. The exterior hyphae are flexuose, contorted, thick-walled to almost solid, 3–5 μ diameter, vivid purple-red to almost hyaline. In some hyphae the colour is confined to the contents, the thick wall being hyaline. A few fine hyphae, 0·5 μ diameter, are present. Here and there, the thick hyphae are fused together side by side in small patches. The hyphae appear to be more rigid than in *T. rubra*, and they tend to break up into short lengths; they are almost smooth, or minutely pitted. In the interior of the stroma the hyphae have more deeply coloured walls. At the base of the stroma, thick-walled hyaline hyphae occur, which are encrusted with granules. Some thick-walled, repent hyphae in the hypothallus are minutely spinulose.

The perithecia usually have a thick weft of hyphae at the base and up to two-thirds their height, which makes them appear conoid. These hyphae are vivid purple-red.

When a stroma has turned brown, the hyphae are pale yellow when mounted; the colour is contained in the cell wall, not concentrated in the plasma. The hyphae appear to bear more granules than those in the purple-red forms. Fig. 5, Plate II, shows a stroma which is changing colour from the centre outwards.

In one collection from Hakgala, April 1917, on *Murraya exotica*, some stromata are pure white, with dull brown perithecia, yellow-brown at the apex, and traces of purple-brown in the stroma round the perithecia. The structure of the stroma is different from that of the normally white Ceylon species.

When the stroma turns brown, the perithecia may remain purple-red; and if the perithecia also become brown, traces of purple-red usually remain in the hyphae at their bases. The specimen from the Seychelles has stromata varying from Sanford brown to pale purple-brown. Their hyphae are red-brown to almost hyaline, strongly encrusted with red-brown granules, while brown amorphous masses occur among them. The perithecium wall retains traces of purple-red at the base. I had assigned this specimen to *T. brunnea* v. Keissl., but on comparison with the other available specimens it appears to be undoubtedly *T. luteorostrata*, and I am of opinion that *T. brunnea* was based on a similar specimen.

The white superficial layer (cf. *T. rubra*), noted by Zimmermann, appears to be of rare occurrence. It occurs in a collection on an Aleyrodid on *Hedyotis verticillaris*, Nuwara Eliya, December 1917.

In a collection on *Fiorinia rubrolineata* on *Saprosma zeylanicum* Bedd., Hakgala, May 1910, there is a thin, dense, hyaline region at the base of the stroma, succeeded by a loose yellow-brown zone, then a more compact, narrow, red-brown zone, followed by another loose yellow-brown zone, and finally a red-brown external layer. Thus, in vertical section the stroma exhibits zonation, which perhaps indicates a periodic stoppage of growth.

The purple-red colour of the hyphae is discharged by lactic acid. Dilute hydrochloric acid turns the hyphae brown. This action of acids may account for the natural colour change of the stroma.

Torrubiella tenuis Petch in Ann. Perad. VII (1922), p. 323.

Stromata pulvinate, flattened pulvinate, or almost plane, up to 1·5 mm. diameter, white, tomentose, rather loose internally, sometimes surrounded by a broad, white, fibrillose margin or hypothallus.

Perithecia usually produced on the thicker part of the stroma, sometimes on the margin or hypothallus, sometimes occurring singly on scales which do not bear any stroma except a slight weft of hyphae at the base of the perithecium, scattered or clustered, elongated flask-shaped or elongated conoid, 0·65–0·9 mm. high, 0·2–0·25 mm. diameter below, pale amber to pale yellow-brown, pale yellow or yellow-brown by transmitted light, subtranslucent, clothed with hyphae up to two-thirds their height, or almost glabrous; asci long, cylindrical, capitate, eight-spored, 7 μ diameter; spores filiform, as long as the ascus, septate, dividing into cylindrical part-spores, 3–6 × 1 μ.

Ceylon; on *Aspidiotus destructor* on a jungle tree, Pundaluoya, coll. E. E. Green, 1899 (Parkin, type 2, p. 19); on a black Aleyrodid on *Sarcococca pruniformis* Lindl., Hakgala, May 1912; on a scale on *Hedyotis Lessertiana* Arn., Hakgala, January 1914; on *Aleyrodes* on *Lasianthus Walkerianus* Wight and *Psychotria elongata* Hk. f., Hakgala, January 1914 (Plate II, fig. 6).

The stromata in this species are usually smaller than in *T. luteorostrata*, and the perithecia in pulvinate examples are situated more usually on the thicker central area of the stroma, and more embedded in it. Old herbarium specimens may acquire a slight brownish tint. Parkin compared this species to *T. tomentosa*, from which it differs in its very slender perithecia.

The hyphae of the stroma are flexuose, thick-walled or almost solid, generally stout, 3·5–5 μ diameter, with a few 2·5 μ diameter. Very fine hyphae, less than 1 μ diameter, have been

observed only in the basal sheet. The external layer of the stroma may in places be a continuous sheet of thick-walled hyphae, more or less parallel, fused together side by side. The hyphae, in general, are not, or only slightly, rough with adherent granules; they are frequently closely septate, and with the wall and septa thickened so that only spherical cavities remain. Short broken lengths of hyphae with thickened walls and close-set septa resemble conidia under a low magnification, but a higher magnification reveals the broken wall at the ends. The hyphae on the perithecia are loosely interwoven, 2–4 μ diameter, thick-walled or almost solid.

Torrubiella sublintea Petch in Ann. Perad. VII (1922), p. 324.

Stromata circular, up to 3 mm. diameter, compact, pulvinate in the centre, with a broad margin, white, margin somewhat floccose, centre acquiring a matted surface which becomes a more or less glabrous wrinkled sheet.

Perithecia situated round the thickened centre, singly or more usually in groups, tomentose up to two-thirds their height, or clothed with mycelium which forms a common covering to two or three perithecia and acquires a glabrous external layer, elongated conoid, slightly attenuated above, 0·75 mm. high, 0·33 mm. diameter below, brownish yellow, darker brown at the apex, subtranslucent, by transmitted light pale yellow to brownish yellow, slightly brown towards the apex; asci long, cylindrical, capitate, eight-spored, 6–8 μ diameter; spores filiform, as long as the ascus, septate, dividing into cylindrical part-spores, 3–6 × 1·25 μ.

Conidia on the stroma or on the perithecia, arising laterally from regular simple hyphae, either fusoid, three-septate, ends acute but not produced, 18–24 × 4 μ, or five-septate, ends strongly attenuated and slightly curved, 36–46 × 3–4 μ, or seven-septate, falcate, ends equally curved and attenuated, 48 × 4 μ.

Fig. 3. Conidia of *T. sublintea*. × 600.

Chili; on an Aleyrodid on an undetermined leaf, Corral, December 1905, coll. Thaxter (Plate II, fig. 7).

The stroma in this species is more compact than in *T. tenuis*. It consists of hyphae, 2–2·5 μ diameter, some thick-walled, slightly rough, others thin-walled, with numerous finer hyphae, 0·75–1 μ diameter. The more compact nature of the stroma is probably due to the fact that the hyphae are thinner than in other species. The tendency of the exterior hyphae to form a continuous layer is very marked, and on some examples the stroma is covered with a glabrous, wrinkled sheet. The stroma sometimes shows traces of pale yellow.

The hyphae at the base of the perithecium are identical with those in the stroma. The hyphae round the perithecium do not exceed 2 μ in diameter, are usually thin-walled, and form a dense outer layer. When two or three perithecia occur in a group, the hyphae of the stroma may ascend almost to their apices, so that the perithecia are deeply embedded in the stroma. Viewed macroscopically, isolated perithecia appear more attenuated above than they prove to be when dissected out, owing to the termination of the external tomentum some distance below the apex.

When first examined this species was thought to be identical with *Torrubiella tomentosa* Pat., but examples of the perithecia from the type of the latter show that it is distinct, though very close. The perithecia are rather similar, but differ slightly in shape and colour, those of *T. tomentosa* being ovato-conoid, not attenuated, with a wall hyaline when mounted, and those of *T. sublintea* elongated-conoid, slightly attenuated at about two-thirds their height, with a pale yellow to brownish-yellow wall. The conidial stages of the two are quite different. Perhaps the most ready means of distinction between them is the occurrence of numerous free, clavate tips on the hyphae which cover the perithecia of *T. tomentosa*.

Torrubiella tomentosa Pat. in Bull. Soc. Myc. France, VIII (1892), p. 133.

Stromata thin, woolly, ochraceous. Perithecia on the stroma, scattered or caespitose, ovato-conical, 0·5 mm. high, 0·3 mm. diameter, pale yellow-brown, slightly darker at the apex, clothed up to the apex with floccose, white (herb. specimen) tomentum; apex obtuse, subtranslucent. Wall of perithecium when mounted almost hyaline with traces of yellow at the apex; tomentum with numerous free, clavate, verrucose tips, and rough with crystalloid masses. Asci long, capitate, cylindrical, tapering below, 6–8 μ diameter, eight-spored. Part-spores cylindrical, tapering slightly towards the ends, 4–7 × 0·75 μ.

Ecuador; on a scale insect on an unknown leaf, Puento de Chimbo (Lagerheim).

In the original description of this species, it was suggested, with a query, that the fungus was parasitic on a spider. Dr Patouillard, who has kindly furnished me with perithecia from the type, informs me that it is certainly parasitic on a coccid.

The foregoing description is drawn up in part from the perithecia examined. The original description gives the perithecia as 1 mm. high and the part-spores 10 × 1 μ. The height of the perithecium given above was taken from an isolated perithecium examined dry; when in water under a cover glass it was 0·75 × 0·35 mm. The hyphae at the base of the perithecium and those forming the tomentose covering are 3–4 μ diameter, with

only slightly thickened walls, strongly verrucose with minute granules, and bear a large number of free clavate ends, up to 5 μ diameter, also strongly verrucose. These hyphae bear spherical or oval, verrucose conidia, 4–6 × 3–5 μ, laterally, in the same manner as that figured for *T. ochracea*. The wall of the perithecium, by transmitted light, appears to be studded rather closely with irregular crystalloid bodies, which are really situated on the external mycelium; they are not soluble in hydrochloric acid.

Torrubiella barda Petch in Ann. Perad. VII (1922), p. 324.

Stromata up to 3 mm. diameter, compact, pulvinate, lacunose, sometimes with a broad, thin hypothallus, orange-yellow, egg yellow, or becoming whitish, more or less tomentose but with the surface layer matted and tending to become membranous and glabrous.

Perithecia round the base of the pulvinate part of the stroma, solitary or clustered, usually surrounded by a weft of hyphae of the same colour as the stroma so that only the ostiola project. Isolated perithecia conoid, yellow, with an outer coat of interwoven yellow hyphae, 0·1 mm. thick, extending nearly to the apex, which is red-brown and conoid; after removal of the tomentose coat, the perithecia are conoid, 0·75 mm. high, 0·35 mm. diameter, suddenly expanding above into a thickened capitate apex; wall of perithecium thick; by transmitted light the wall of the perithecium is yellow and the thickened apex orange or reddish-yellow. Asci long, cylindrical, capitate, eight-spored, 6–7 μ diameter; part-spores cylindric, becoming somewhat narrow-oval with obtuse ends, 4–7 × 1·5 μ.

Chili; on an Aleyrodid on an undetermined leaf, Corral, December 1905, R. Thaxter (Plate II, fig. 8).

In some instances all the perithecia are embedded in the stroma, which then resembles a *Hypocrea*, dotted with red-brown ostiola. The structure of the perithecium is quite distinct from that of the other species of *Torrubiella* found on scale insects. At first sight, it appears regularly conoid, tomentose below, glabrous at the apex. The tomentose layer, however, can be easily peeled off, and it is then found that the wall of the perithecium suddenly expands at right angles at the upper limit of the tomentum, so that a thick solid apex is formed.

The hyphae in the tomentose layer on the perithecium are thick-walled, almost solid, closely interwoven; this layer is yellow, but becomes pale or white internally. The hyphae of the stroma are usually stout, generally 4–5 μ diameter, but with some 2–3 μ diameter, thick-walled, flexuose, encrusted with granules, greenish yellow to hyaline; they tend to fuse into a continuous superficial sheet.

The type of *Acremonium araucanum* Speg. has been kindly

lent me by Dr Spegazzini. This is on an *Aspidiotus* on *Drymis Winteri*, collected at Bahia de Corral, Chili. The fungus forms a more or less pulvinate, lemon yellow stroma over the scale, with a thin spreading margin, composed of thick-walled, yellow or hyaline, irregular hyphae, often closely verrucose. There is no doubt that these are the stromata of a *Torrubiella*, and in one example a developing perithecium was present. They appear to be undoubtedly the stromata of *T. barda*. Numerous conidia, hyaline or yellowish, verrucose, oval, 4–5 × 3 μ, or globose, 3–4 μ diameter, were seen, usually singly, sometimes in chains, but these all arose from thin-walled, hyaline hyphae, 1·5 μ diameter, which did not appear to be connected with the hyphae of the stroma. Spegazzini described the conidia as ellipsoid, 7–8 × 6 μ; it is probable that he saw other conidia which are those of the conidial stage of *Torrubiella barda*.

Torrubiella Lecanii Johnst. in Mem. Soc. Cubana Hist. Nat. "Felipe Poey," III (1918), p. 80.

Perithecia vivid yellow, erect, conical, scattered or confluent, 350 μ high, 125 μ diameter. Asci linear, 175–245 μ long. Ascospores dividing into cylindrical part-spores with rounded ends, 3·32 × 1·66 μ.

Cuba; on, or with, *Cephalosporium Lecanii* on *Saissetia hemispherica* on *Achras Sapota*.

The above is Johnston's description. I have not seen a specimen. Mr Johnston, *in litt.*, states that the perithecia were yellow, with rather translucent yellow ostiola, and necks somewhat tapering or rounded at the apex; isolated perithecia were yellow-tomentose, but when several grew close together they were invested by yellow mycelium. On the characters of the apex of the perithecium, *T. Lecanii* would appear to be quite distinct from *T. barda*.

To afford a comparison with the species of *Torrubiella* which are parasitic on other insects, the following account of the other known Ceylon species is included. One of these, which occurs on an undetermined Noctuid, appears to be *T. ochracea* Pat. The other, which is apparently a new species, occurs on spiders; it is described below as *Torrubiella flava*.

Torrubiella ochracea Pat. In two examples of this species, collected on different occasions on the perfect insect, a rather loose pale yellow weft of hyphae extends along the body and the legs of the insect and binds them to the leaf. This mycelium does not cover the wings, but it fastens the wings to the body, and comes just up to, or slightly over their margins. When old the colour of the mycelium fades to almost white. The perithecia occur anywhere on the mycelium, but more particularly along the margins of the wings and along the legs; they may be scat-

tered or in groups of up to a dozen (Plate II, fig. 11). In another example, on a caterpillar, the perithecia are situated on the mycelium which covers it.

In two other examples, the insect bears a denser weft of hyphae, and from this there arise erect processes, up to 5 mm. high, usually laterally compressed and up to 1 mm. broad. These processes are composed of adherent longitudinal hyphae, and they do not contain any remains of the insect which might serve as a foundation. The perithecia are superficial, crowded together at the apices of the processes. In both these examples, the mycelium and the processes are white. One specimen bears sixteen of these processes (Plate II, fig. 12).

The perithecia are pale yellow when fresh, becoming ochraceous or reddish-brown when old; they are subtranslucent, oval or conoid, with an obtuse or papillate apex, 0·35–0·65 mm. high, and 0·2–0·3 mm. diameter below. The perithecial wall is pruinose above, clothed with pale yellow hyphae below; when mounted, it appears pale yellow, membranous, of indistinct structure. The asci are 4–5 μ diameter, and the part-spores cylindrical, tapering slightly to the rounded ends, 5–7 × 1–1·25 μ.

The hyphae in the weft of mycelium are generally regular, septate, 1·5–2·5 μ diameter, thin-walled or with a slightly thickened wall, with occasional oval inflations up to 6 μ broad. The septa are 15–28 μ apart. The hyphae bear spinulose, hyaline conidia, either globose, 2·5–3·5 μ diameter, or oval, 4 × 3 μ. These occur laterally and singly, widely separated along the hyphae, usually each immediately below a septum, in the position of a lateral branch. In some cases, both a branch and a conidium are produced just below a septumin the main hypha.

Occasionally short lengths of the hyphae are closely septate, with septa as little as 4 μ apart. The lateral branches are frequently short, with some of the cells inflated, and terminate in an oval cell furnished with a solid, acuminate tip.

The *Torrubiella* and the *Cordyceps* forms agree in the structure of the hyphae, the conidial stage, the colour and structure of the perithecia, and the dimensions of the part-spores. In the *Cordyceps* form, the mycelium grows into erect solid processes, while in the *Torrubiella* form it is only a rather loose weft of hyphae. This difference in the development of the mycelium may possibly be due to differences in the conditions under which these examples grew. The *Torrubiella* form was collected on living leaves, but the *Cordyceps* form was found, unattached, among dead leaves on the ground.

These specimens of *T. ochracea* support Möller's contention that the genus *Torrubiella* is not distinct from *Cordyceps*, because of the existence of transitional forms. Nevertheless, it may be considered advisable to retain it for those species which

do not form a clava, while agreeing that the two genera are united by species which, in their different forms, combine the characteristics of both.

Reference has already been made to the probability that *Cordyceps Moelleri* P. Henn. and *C. cristata* Möll. are forms of the same species, parallel to the two forms of *Torrubiella ochracea* Pat. Lloyd has suggested that *Cordyceps Moelleri* P. Henn. is identical with *C. Sphingum* Tul., and that suggestion would appear to be correct. The question then arises whether *Torrubiella ochracea* is not also identical with *Cordyceps Sphingum*. Macroscopically, the two differ in the shape of the processes, those of *Cordyceps Sphingum* tapering upwards and

Fig. 4. Conidia of *T. ochracea*. × 800.

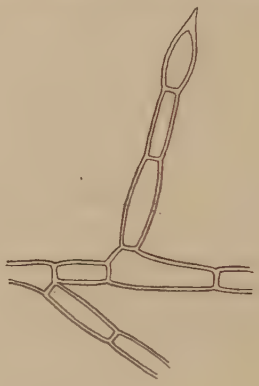


Fig. 5. Hyphae of *T. ochracea*. × 1000.

having the perithecia scattered or clustered at some distance below the apex, so that the clava terminates in a long barren point, while those of *Torrubiella ochracea* are more or less obtuse and have the perithecia clustered at the apex in the available examples. But it is probable that this difference will prove not to be constant. The other differences are slight. *Cordyceps Moelleri* is described as pale yellow, while the species of *Torrubiella ochracea* which possess clavae have a white stroma, but it is known that the yellow colour of the *Torrubiella* forms of the latter fades to white. The perithecia of both species appear to be the same shape, while the length of the part-spores is 5–6 μ in *Cordyceps Moelleri*, 4 μ in *C. cristata* (both according to Möller), and 5–7 μ in *Torrubiella ochracea*. Only Hennings gives the diameter of the spore of *Cordyceps Moelleri* (0·5 μ), and it would appear that he did not see the mature part-spores.

It would seem probable, therefore, that *Torrubiella ochracea* is identical with *Cordyceps Sphingum*, but a final decision on the point must be deferred until a comparison can be made with authentic specimens of the latter.

Torrubiella flava Petch, n.sp. This species (Plate II, fig. 9) occurs at Hakgala, Ceylon, on spiders. In the specimens hitherto collected, the insect is attached by the mycelium of the fungus to the under surface of living leaves. The fungus clothes the body of the insect with pale yellow mycelium, forming a flattened-pulvinate, tomentose, somewhat spongy stroma, with a fimbriate margin spreading slightly over the leaf. The hyphae of the stroma are 2·5–3 μ diameter, usually thin-walled, but sometimes with walls up to 0·5 μ thick, especially towards the free ends of the hyphae. The perithecia are seated on the stroma, superficial, ultimately crowded, tomentose with a rather thick, separable layer of tomentum, pale yellow, with a yellow-brown translucent apex, ovoid, 0·8 mm. high, 0·4 mm. diameter. The hyphae of the tomentum are 2–2·5 μ diameter, moderately thick-walled, and minutely granular. The asci are long, cylindric, capitate, 5–6 μ diameter, four or eight-spored. The ascospores are as long as the ascus, and divide into cylindric part-spores, 5–8 × 1·5 μ, the septa in the undivided spore being exceptionally well-developed. Paraphyses are present, as long as the asci, thin-walled, lax, collapsing, not capitate, expanding to 3 μ diameter at the apex.

A specimen (Plate II, fig. 10) on the same species of spider, gathered with the foregoing and possessing a stroma of the same character, bears conidial *Stilbum*-like clavae. These are pallid yellow, cylindric, up to 4 mm. high, 0·15 mm. diameter, tapering slightly upwards, terete, smooth. They are clothed with spherical or subglobose basidia, up to 6 × 5 μ, scattered or crowded, each bearing a single apical, slender, rigid sterigma, about 2 μ long. The conidia are apical, narrow-oval, ends acute, continuous, hyaline, 4–8 × 2 μ. This is a *Hirsutella*, which has been described as *Hirsutella arachnophila* Petch (= *Trichosterigma arachnophilum* Petch). The perithecia and the conidial clavae have not been found on the same stroma.

Hirsutella arachnophila has also been collected at Peradeniya, on spiders, on two occasions. In one of these examples, the clavae were lilac-grey when fresh. It is possible that the latter may belong to a different species, but it does not show any morphological differences. A similar difference in colour occurs in *Gibellula elegans* P. Henn., in which species both the stroma and the conidiophores may be yellow, or the stroma yellow and the conidial heads lavender. In the latter case, the conidial heads become white in old herbarium specimens.

It would seem probable that the conidial stage mentioned by Raciborski as occurring with *Barya montana* may have been *Hirsutella*, but it was not described further.

EXPLANATION OF PLATE II.

Fig. 1. *Torrubiella rubra*, specimen from Corral, Chili, ×6: the perithecia which show circular ostiola have been broken.
Fig. 2. *T. luteorostrata*, Hakgala, Ceylon, ×10, form with a white stroma.
Fig. 3. *T. luteorostrata*, Hakgala, Ceylon, ×10; specimen showing yellow ostiolum.
Fig. 4. *T. luteorostrata*, Hakgala, Ceylon, ×10.
Fig. 5. Stroma of *T. luteorostrata*, Hakgala, Ceylon, changing colour from purple-red to brown, ×6.
Fig. 6. *T. tenuis*, Hakgala, Ceylon, ×6.
Fig. 7. *T. sublintea*, Corral, Chili, ×12.
Fig. 8. *T. barda*, Corral, Chili, ×6.
Fig. 9. *T. flava*, Hakgala, Ceylon, ×8.
Fig. 10. *Hirsutella arachnophila*, Hakgala, Ceylon, ×8.
Fig. 11. *Torrubiella ochracea*, *Torrubiella* form, ×3.
Fig. 12. *T. ochracea*, *Cordyceps* form, ×3.

PROCEEDINGS, 1923.

MEETING. UNIVERSITY COLLEGE, LONDON. *20th January.*

Dr W. Brown and Dr A. S. Horne. *Fusarium.*
Mr J. Ramsbottom. Berkeley and Broome.
Miss W. F. F. Ridler. The Fungus present in *Lunularia cruciata.*
Dr H. Wormald. Crown-Gall in Nursery Stock.
Mrs N. L. Alcock. *Polystictus versicolor* parasitic on Apple.
Miss E. M. Wakefield. *Fomes applanatus* and *F. fomentarius.*

MEETING. UNIVERSITY COLLEGE, LONDON. *17th March.*

Rev. P. J. Alexander, C.J. An ecological and phenological account of the Mycetozoa of Surrey.
Miss M. H. Carré, Dr A. S. Horne, Miss H. M. Judd and Mrs H. S. Williamson. *Eidamia.*
Dr J. S. Bayliss Elliott and Miss O. P. Stansfield. The life history of *Polythrincium Trifolii* Kunze.
Mr J. Ramsbottom. 1. The correspondence of Berkeley and Broome.
2. Mycology at the British Empire Exhibition (1924).

SPRING FORAY, BRISTOL. *20th—24th April.*

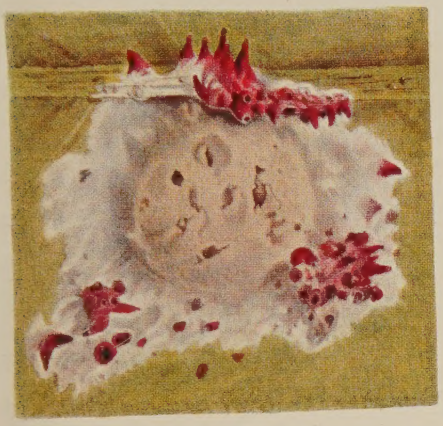
Visit to Ashton Court Park and Long Ashton Horticultural Research Station.
Visit to Mushroom beds in disused Bathstone quarries at Corsham, Wilts.
Visit to Wrington.
Miss B. M. Breeze. Pollen sterility in potato.
Mr F. E. Smith. *Mycogone* disease in Mushrooms.
Miss E. M. Wakefield. *Rhizoctonia violacea* and *Helicobasidium purpureum.*

SPRING FORAY FOR LONDON STUDENTS. *5th May.*

Visit to Effingham.

PHYTOPATHOLOGICAL MEETING. *7th July.*

Visit to South Eastern Agricultural College, Wye.



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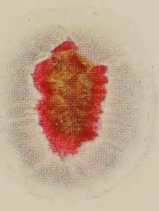

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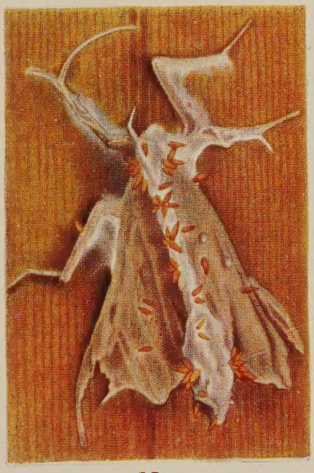

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A. George Alwis, del.

TORRUBIELLA